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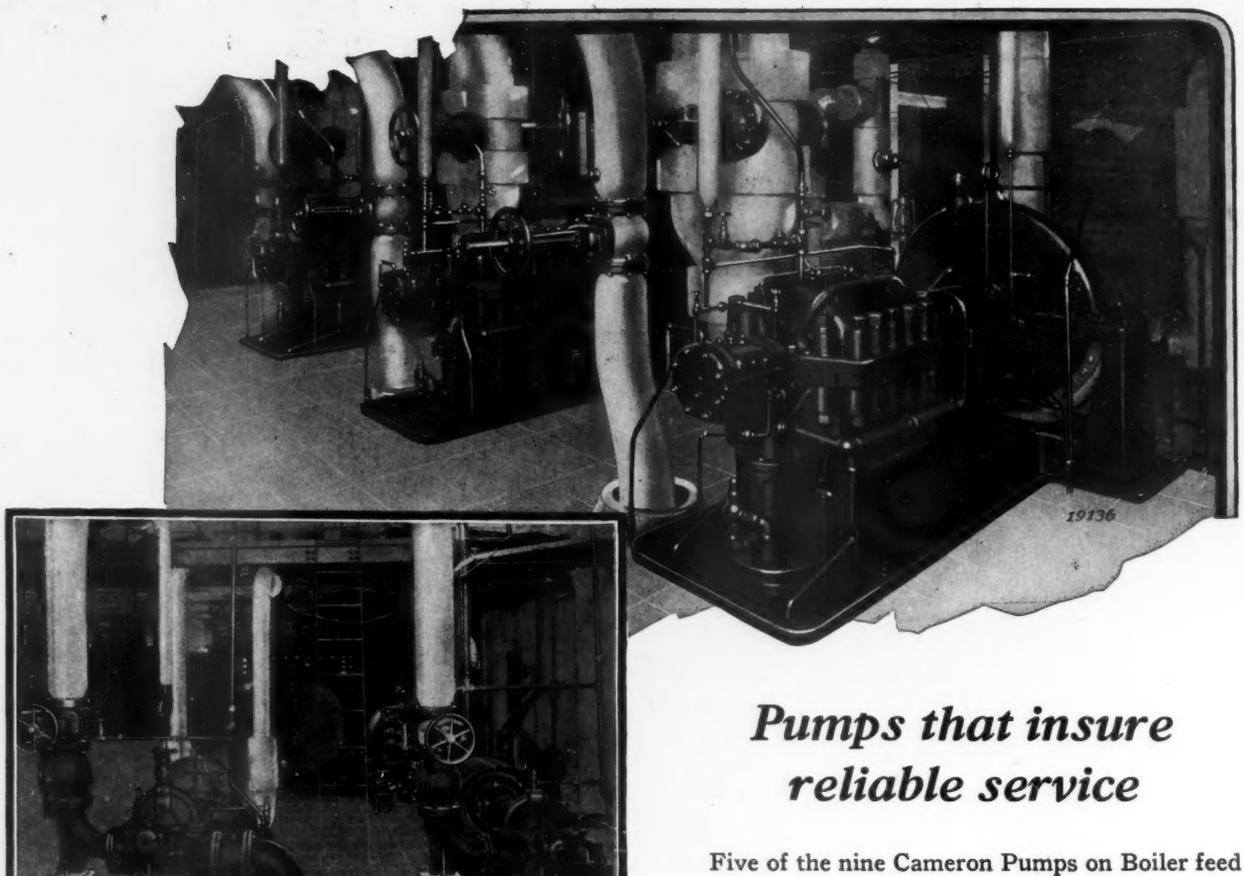
FOR MODERN POWER PLANTS



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Sayre Shops Of The Lehigh Valley Railroad

Where Time and Money are Saved by Up-to-date Methods and the Most Modern of Facilities

By ROBERT G. SKERRETT

THE Lehigh Valley Railroad links the Great Lakes at Buffalo with the Atlantic Ocean at the Port of New York; and in covering the intervening distance of substantially 447 miles, the line crosses a part of the Allegheny Mountains. A casual glance at a map of the territory traversed will reveal the industrial importance of the region served. It should therefore cause no great surprise to learn that the road has to its credit a matter of 5,867,909,823 ton-miles of freight moved in the course of a single year.

By intensive and well-directed efforts the roadbed and the mobile equipment of the road have been brought up to such a condition of efficiency and readiness that the line, although handling more traffic than ever before, is actually in a position to accommodate 25 per cent. more business without adding to its facilities in any way. This state of affairs is due to the wise course pursued by the management since the Federal Government relinquished wartime control.

Although double tracked with the heaviest of steel rails laid on closely spaced ties resting on a rock-ballasted roadbed, still steep grades have to be negotiated and stiff curves rounded in maintaining the schedules set for the line's heavy and speedy trains of all sorts. But the burden of keeping up this flow of traffic rests, in the last analysis, upon the locomotives of the road of which there are 1,003 of various sizes and types. As will be readily grasped, the cold months of a year are the most troublesome ones, especially in a section of the country such as the line crosses where temperature changes are great and snow and sleet are no rarity.

During the last two or three years, the locomotives of the Lehigh Valley Railroad have been thoroughly reconditioned; and because of this the system is now in a better position to deal with contingencies than it has been at any previous time in the past decade. In December of 1923, there were available in reserve but 20 locomotives. The road faces the work of the present winter with a reserve of 118 locomotives—70-odd of which are in readiness in white lead in the yard of the shops at Sayre. This situation tells something of the story of the intensified and carefully coördinated efforts of the great plant in question, which does the major part of locomotive repair work for the entire system.

STANDING on their tiptoes. This fittingly describes the attitude of the best of our trunk-line railroads in their effort today to show the largest practicable return upon the money invested in them.

It is highly desirable that the people at large should know more about what the railroads are doing the better to serve the public in various ways. All too few of us are aware of the multiplicity of things that must be done, and done well, in order that locomotives and cars can be kept in condition to meet the diversified and the exacting demands made upon them.

The present article has been prepared to promote a popular understanding of what is involved in overhauling and in repairing the rolling stock of a great railway system, and to this end we give our readers a glimpse of the manysided activities carried on in the splendid shops of the Lehigh Valley Railroad at Sayre, Pa.

Before describing what is done at the Sayre shops, let us touch briefly upon the added task imposed upon the locomotive in bad weather. To begin with, a cold atmosphere draws heat by radiation from the exposed surfaces of the boiler and the cylinders and makes it that much harder to hold the steam pressure at the point of maximum efficiency. Further, the oil in the journal boxes of the cars is congealed, and instead of acting as a lubricant the oil, for the time being, increases resistance and makes it that much more difficult for a locomotive to get a train in motion and to bring it up to the prescribed speed. Therefore, even without the hampering action of impeding snow and slippery rails, fewer cars can be hauled by an engine and more locomotives are needed to pull a given tonnage. Manifestly, then, the winter season is the most troublesome one; and the Lehigh Valley Railroad's reserve of motive power is an index of what the road has done to insure that excellence of service which its patrons confidently expect.

The system shops at Sayre have a working force of 1,440 employees; and it is interesting to note that this organization has replaced one that totaled 2,000 about two years ago. While the shop force has been reduced by nearly 30 per cent., the output per man has been increased by 50 per cent. The piece-work basis of compensation prevails in 75 per cent. of the jobs performed; and the satisfying results obtained are in no small part due to the up-to-date tools and to the labor-lightening facilities placed at the disposal of the men. No small percentage of this money-and-time-saving equipment is operated by compressed air.

Under normal conditions, every locomotive is "shopped" for overhauling at least once a year—this is a matter of routine. But the volume of work done at Sayre is swelled by emergency demands which range all the way from light to heavy repair jobs; and at the present time the plant is turning out locomotives, thoroughly refitted for service, at the rate of one and a half units every working day. To maintain this output, it is necessary to keep every one of the 52 working pits filled continually and to utilize an industrious force of 950 machinists, blacksmiths, and boilermakers. Perhaps it will help to visualize the scene of activity if we say that the main locomotive shop is 365 feet wide and 750 feet

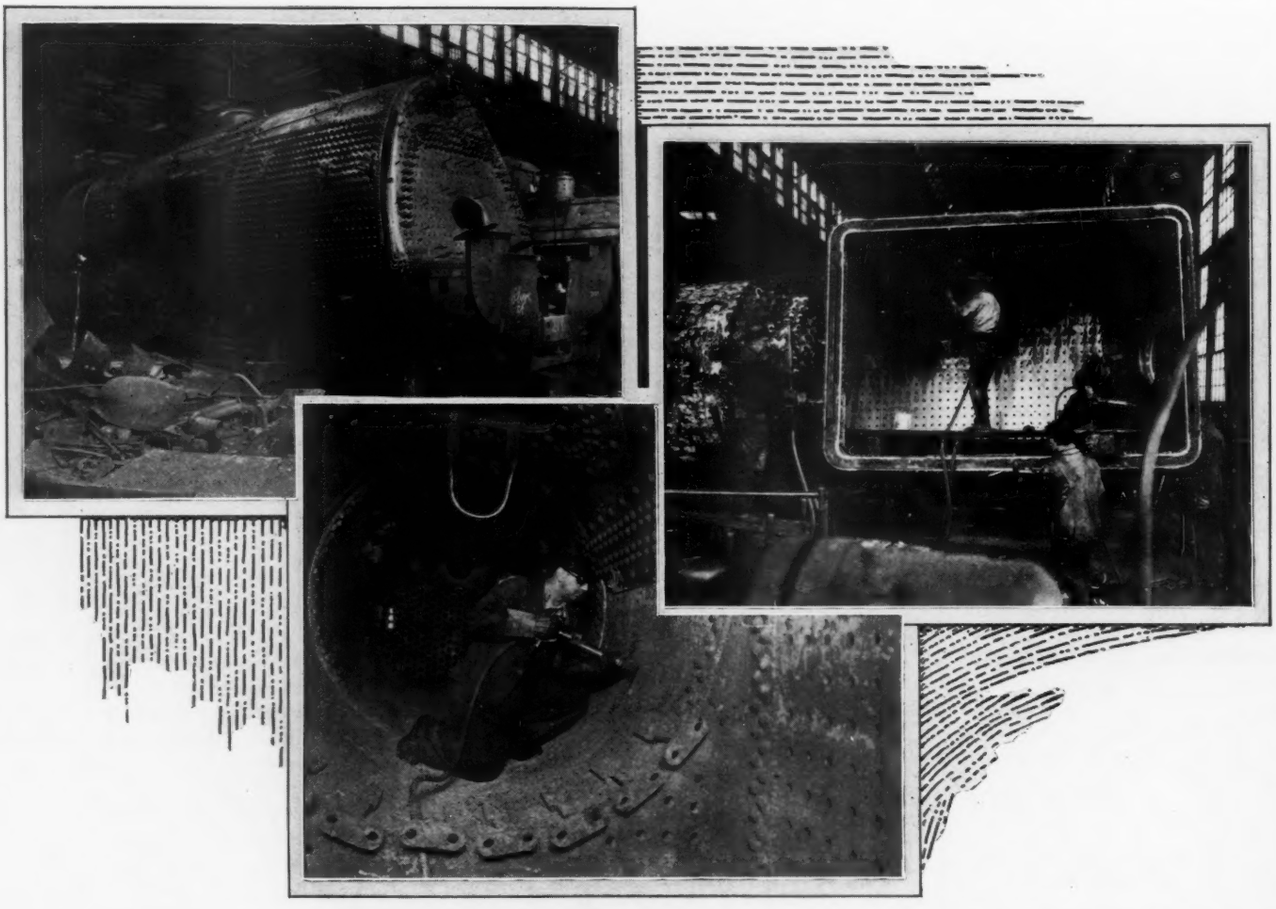
long, and that the blacksmith shop is 100 feet wide and 360 feet long. Powerful cranes and numerous lesser hoists make it possible to lift and to transport any weight essential to the tasks in hand; and machine tools of an endless variety do all kinds of metal work that may be required. Jitney trailer-trains worm their way in and out of the busy aisles and bays of the shops, moving from storerooms to other points the lighter materials and parts needed for a variety of purposes. It is apparent everywhere that the aim is to cut out lost motion and exhausting muscular effort so that the skilled workers can concentrate their energies on the really important tasks.

As might be expected, the locomotives on the line include the various classes that are called upon to haul slow and fast freight trains as well as those that draw passenger trains of different kinds on long and short runs. The work required of them is made possible by sustained steam pressures of from 175 to 215 pounds—depending, of course, upon the class of locomotive and the service to be performed by it. And this brings us to what might properly be termed the "vitals" of a locomotive—in brief, the boiler.

The purpose of the boiler is to burn fuel so effectively that water can be transformed into high-pressure steam fast enough to meet the demands of the driving cylinders. From the very nature of things, the conditions under which a locomotive boiler operates are far more severe than would be the case if it were stationary and housed. The mobile boiler must be sturdier and, withal, more flexible than a stationary one of kindred design; and to meet these requirements special structural expedients are resorted to. Among these are stay bolts—both rigid and flexible, by which the sides and the crown of the fire-box, for example, are bound to the enveloping shell or barrel of the boiler. In passing, let it be said that water is carried between the fire-box and the shell.

The inner surface of the fire-box lies next to the fire-bed or is directly exposed to the flames and hot gases issuing from the burning fuel, while the opposite surface of the fire-box structure is in contact with the water that is to be converted into steam. One surface of the boiler shell is likewise in touch with this water, while the exterior surface of this plating is, to a considerable extent, exposed to the atmosphere. Manifestly, neighboring sections of the fire-box walls and the enveloping shell are subjected to widely differing temperatures that cause opposing movements by reason of unequal expansion and thus s up pronounced stresses in the associate pla ing. Therefore, in order to take care of thes opposing movements, stay bolts of vario sorts are employed to bind together the fir box and the boiler barrel. To be specifi rigid stay bolts are used where there is lea movement, and where expansion and co traction are greatest flexible stay bolts a relied upon to provide the necessary bond The longest of the flexible stay bolts are th radial ones by which the crown sheet or to of the fire-box is tied to the overlying she plating.

In the case of a large freight locomotiv of the Mikado type there are fitted 450 rigi

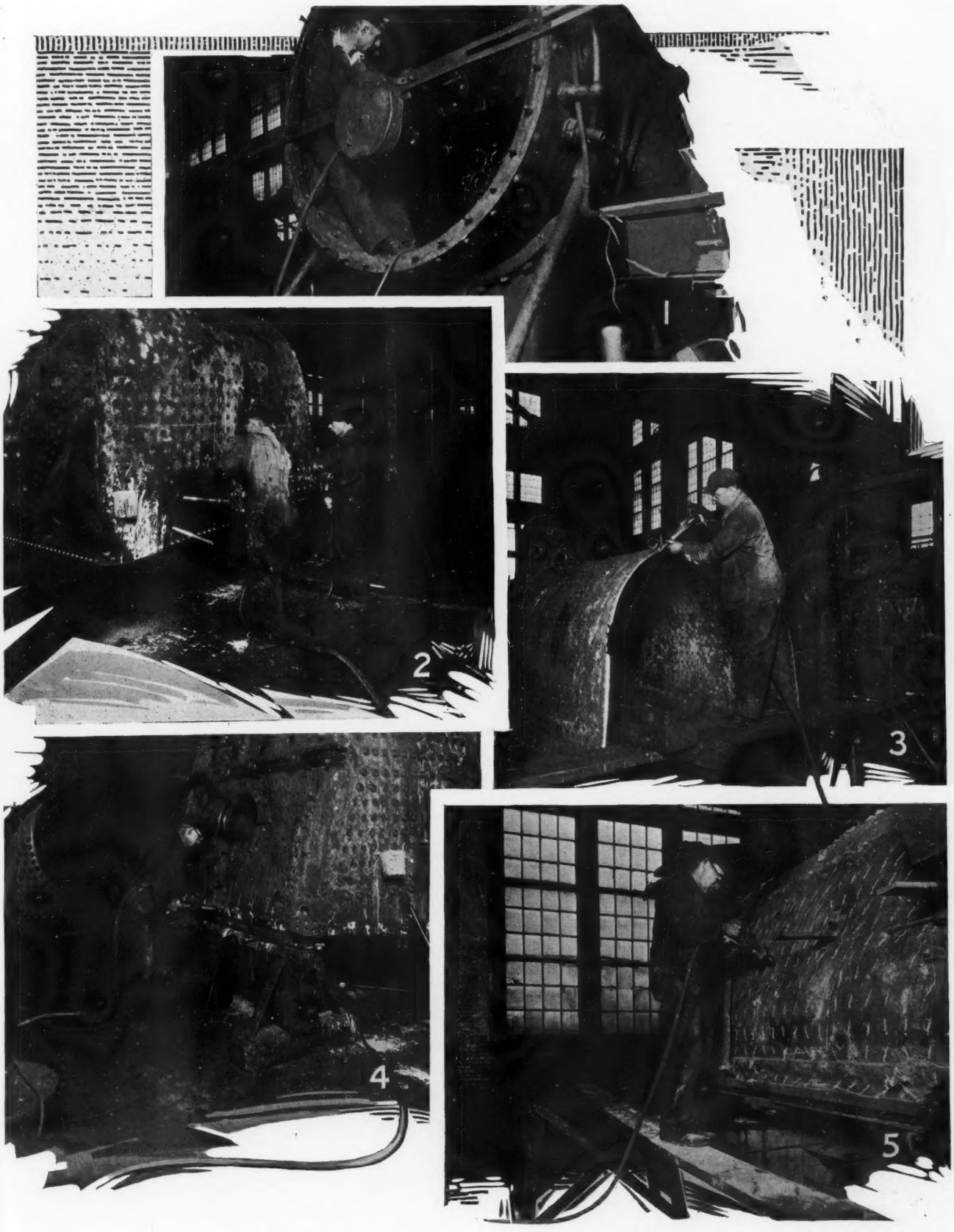


Left—How a locomotive looks when stripped down for general overhauling. Note the numerous caps of the flexible stay bolts at th fire-box end of the boiler.

Right—Five operations being carried on simultaneously: drilling stay-bolt holes, reaming stay-bolt holes, upsetting the ends of rig stay bolts, screwing on the caps of flexible stay bolts, and chipping plating along the mud ring—all this work being done with pne matic tools.

Bottom—An air-driven chipper scaling the interior surface of a locomotive boiler.

532 crown, and 1,740 flexible stay bolts— short, a total of 5,444 holes must be punch or drilled and afterwards tapped to hold place the two ends of each bolt. This tappi is done after the shell and the fire-box a assembled; and the work is particular troublesome in the case of the holes for t crown bolts. Air-driven drills do the jo and tools of this kind also run the stay bol into position and screw home the sleeves a caps of flexible stay bolts. The two ends each rigid bolt and the inner end of ea flexible bolt are upset or headed with



Overhauling a locomotive boiler with Ingersoll-Rand tools.

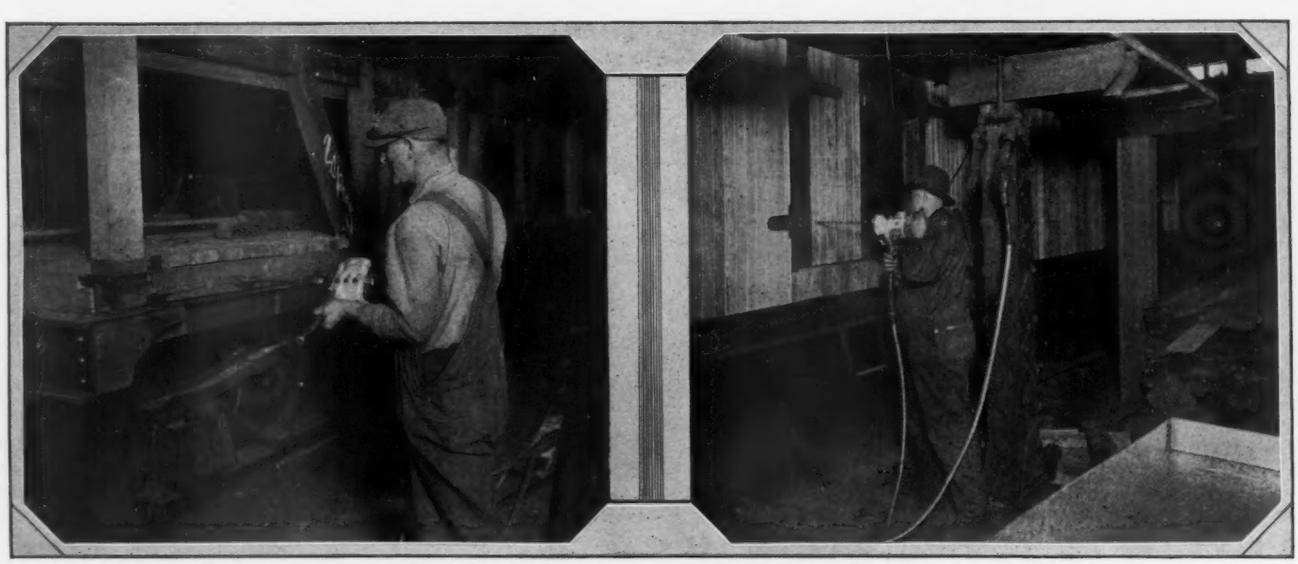
Fig. 1—One man can operate this special attachment which rolls 5½-inch superheater tubes.
Fig. 2—Air-driven drills tapping stay-bolt holes in a fire-box sheet.
Fig. 3—This air-operated chipper is doing fast work on a fire-box wrapper sheet.
Fig. 4—Riveter driving ⅞-inch rivets in a mud ring.
Fig. 5—Drilling tell-tale holes in the outer ends of rigid stay bolts.

Left—IR drill driving screws in running-board saddles on a refrigerator car.
Right—Circular saw, operated by a small air-driven drill, used to trim the edges of box cars.

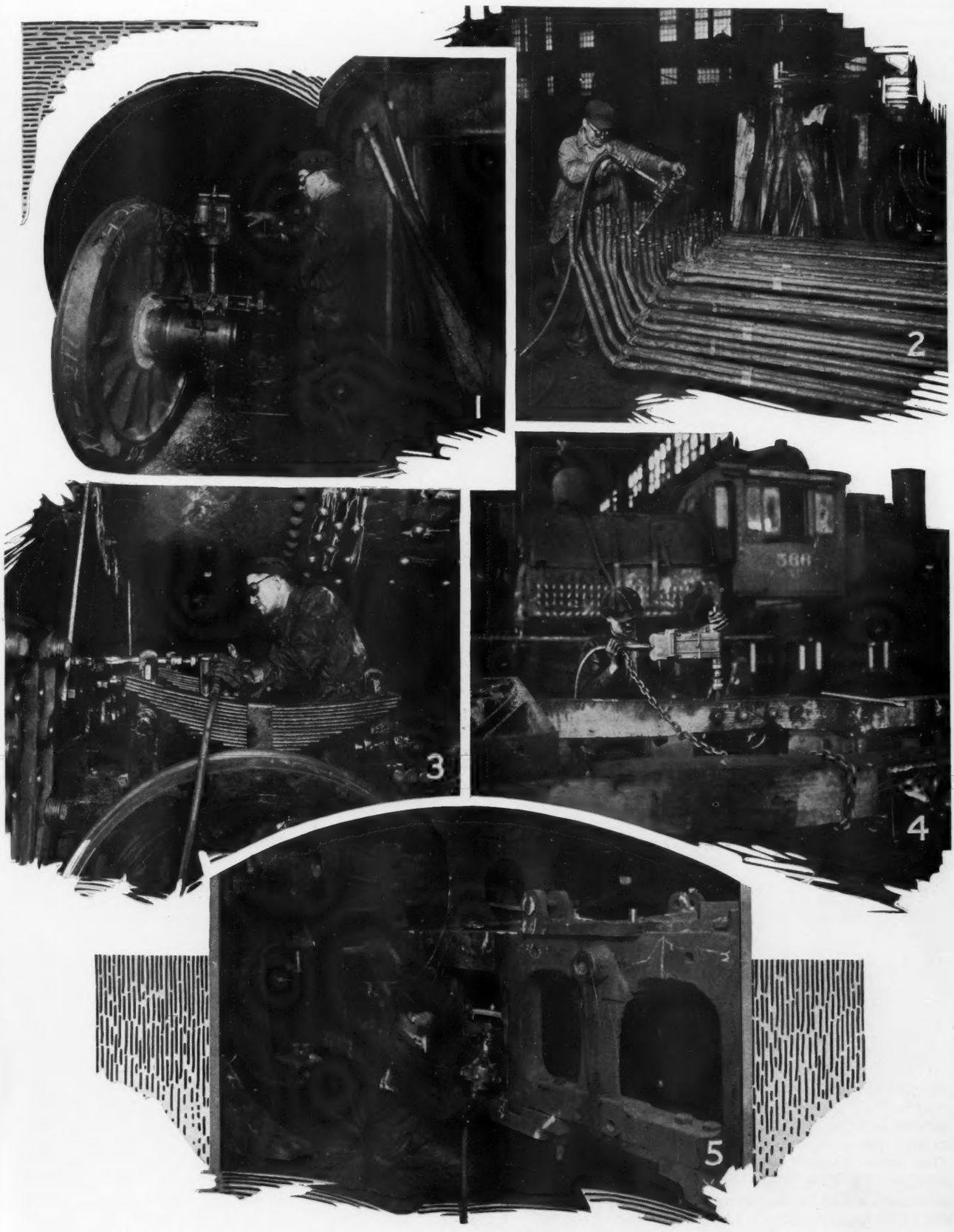
hammers to anchor them and to make them water and steamtight. There are also 316 rivets in the make-up of the fire-box of such a locomotive; and these are likewise driven tight by air hammers. We might mention here that many of the holes in the boiler plating may have to be reamed, and pneumatic tools are used for this purpose. In the outer end of each rigid stay bolt, at the center, there is drilled a 3/16-inch hole to a depth of 1¼ inches. The object of this tell-tale hole is to permit water or steam to escape should the bolt become cracked or broken—thus giving visible evidence of the failure. Air drills make these holes. As a matter of information, the fire-box of a Lehigh Valley passenger locomotive of the "K Class" requires 2,335 stay bolts, of which 2,048 are flexible ones. These figures are given so as to make it easier for the general reader to grasp the nature of the task involved in repairing or in renewing a fire-box.

By far the larger percentage of the heat transfer, which causes the water to generate steam, is effected by the passage of the hot gases stackward through a numerous aggregation of longitudinal tubes generally designated as flues. These tubes are secured to the flue sheet at the forward end of the fire-box and to another flue sheet a short distance back from the smokestack. In a Mikado locomotive of the size already referred to there are no fewer than 299 of these tubes—45 of the being 5½ inches in diameter and 254 of the 2¼ inches in diameter. In the case of "K Class" passenger locomotive there is total of 243 of these tubes. The 5½-inc tubes are superheater tubes, and in each them there is a superheater unit made up four 1-inch tubes. These units serve to rai the temperature of the dry steam to abo 700°F.—in this way greatly increasing the pr pulsive action of the steam when it final reaches the driving cylinders.

As can be readily grasped, the ends of t flues near the fire-box are subjected to mo intense heat than the opposite ends in t neighborhood of the smokestack, and, ther



Left—Boring 1⅛-inch holes in the wooden frame of a box car by means of an air-driven drill.
Right—Boring small holes for hinge screws in the door of a refrigerator car with another air-driven tool.



Some of the many Ingersoll-Rand tools used in the Sayre shops.

Fig. 1—Drilling ⅞-inch holes in a trailer wheel for a hub liner.
Fig. 2—Grinding the joints of superheater units.
Fig. 3—Close-quarter drill reaming 1¼-inch holes in a cylinder saddle.
Fig. 4—Reaming holes in a locomotive frame with a close-quarter drill.
Fig. 5—Dressing the inside of a jaw on a locomotive frame with a grinder.

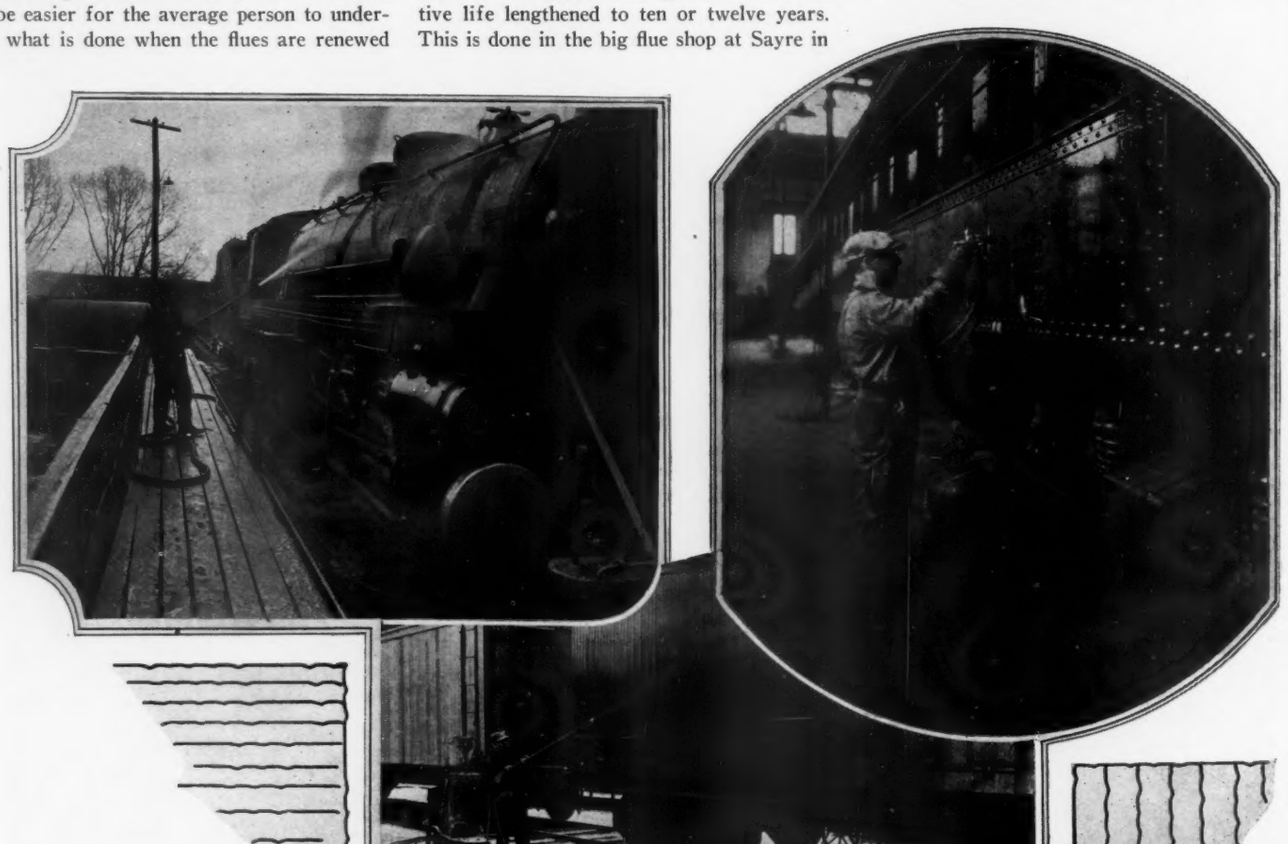
fore, severe and opposing stresses are set up in these tubes. Accordingly, much care must be exercised not only to bind each end of each tube securely to its associate flue sheet but to make this union both steam and watertight. To accomplish this, the slightly projecting end of the flue is expanded until it makes a tight fit with the enveloping hole in the flue sheet, and then this "belled" or expanded metal is rolled over outwardly in order to draw the flue snugly against the sheet. Air-driven tools are employed to expand and to bead the flues. It will now be easier for the average person to understand what is done when the flues are renewed

then by folding them in with a chipping hammer, or the tubes may be released by a flue cutter operated by an air drill—after which they are backed out through the fire-box tube sheet by means of an air-driven hammer. When all the tubes have been removed, the interior of the cylinder or barrel of the boiler is thoroughly cleaned by pneumatic scaling hammers. This is necessary to make it possible to examine the plating as well as the rivets and the seams.

In the majority of cases, used boiler tubes can be made serviceable again and their effective life lengthened to ten or twelve years. This is done in the big flue shop at Sayre in

paired tubes are placed again in a locomotiv boiler.

One by one, the tubes are shoved through th front flue sheet until the rear end of each tub rests in its appropriate hole in the back tub sheet. Then a worker tightens the rear en of each flue with a tool called a 5-section pros ser—the sections of which are spread outwar by means of a tapered pin driven with an ai hammer. The end is next flared or belled wit a sectional expander, and this is followed by



Left—Cleaning and glossing the metal surfaces of a locomotive with a mixture of oil and water sprayed by compressed air. Right Spray painting a metal coach. This process saves both time and paint. Bottom—Much of the spray painting of freight cars is done in the yard, and the work costs a good deal less than it would if done by brush.

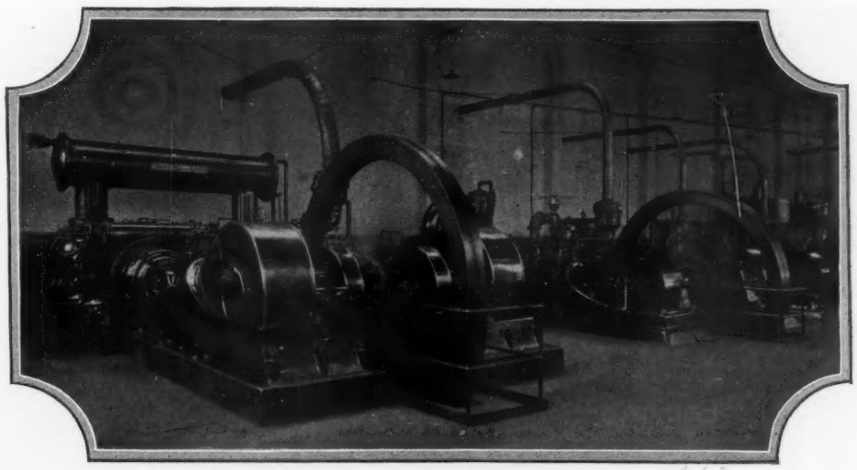
—an overhauling or repair operation which commonly takes place about every three years. Work of this sort is classed as a heavy repair job; and its execution requires the greater part of a month.

To remove a boiler tube, the bead at the fire-box end is cut off with a pneumatic hammer. This work is made somewhat harder when, as in the case of the Lehigh Valley Railroad, the fire-box end of the flues are electrically welded to the flue sheet after the boiler has been in active service for a while. The front ends of the flues, where they terminate at the smoke-box, are loosened by splitting them from one to two inches inside of the tube sheet and the following manner: First, the defective end or ends of each flue are cut off; next, a replacing piece is added to the tube by an electric butt-welding machine—the clutch of which is operated by compressed air; then the welded flue is quickly tested by steam at a suitable pressure; the fourth step consists of heating the new end in a furnace fired with oil sprayed by compressed air, after which the end is swaged by an air-driven hammer; and, finally, the tube is cut to a prescribed length. In the flue shop, the flues are piled and transferred from point to point or from floor to car by air hoists which reduce manual handling as far as is practicable. Now let us see how these re-

beading operation that seals the tube to sheet—a pneumatic beading tool performing work. The front end of each flue is tighten by a roller which is usually actuated by an drill. We have been describing the steps which the 2¼-inch tubes—commonly designa as "flues"—are installed. Both the back the front ends of the superheater tubes—spok of as "tubes"—are treated alike when be replaced. The prossering, expanding, belli and rolling are all done with pneuma tools.

In routine service, the proper practice is blow the flues of a locomotive after every c siderable run in order to clear them of dust

cinders so that their heating surfaces will be able to transmit a maximum measure of heat to the water surrounding the tubes. The need of keeping the flues and tubes clean can readily be appreciated if we consider what each of them does towards transmitting heat to the water. Assuming the tubes to have a common length of 24 feet, each 2¼-inch flue has an internal heating surface amounting to 14 square feet, while each superheater tube has a heating surface of substantially 35 square feet—not counting the heating surface of the superheater coils or units installed within each 5½-inch tube. If neglected, flues and tubes may become so tightly plugged that they can be cleared only by resorting to long steel augers, or they may have to be completely removed from the boiler. Pneumatic flue cleaners have been devised for this service; and in one form or another are widely used in all up-to-date roundhouses and locomotive repair shops.



Compressor end of the engine-room of the fine power plant at Sayre. The four compressors have a combined output of 11,700 cubic feet of free air per minute at a pressure of 100 pounds to the square inch.

When a locomotive is sent to the Sayre shops for retubing and for the general overhauling of its boiler, it is customary then to rebore the cylinders as well as the valve chambers. This is necessary because the bores of the cylinders and the valve chambers become elliptical in shape by reason of the unequal wear of the rapidly moving heavy pistons and valves. In time, successive reborings reduce to the permissible limit the thickness of the cylinder walls, and when this state is reached the cylinders are relined or rebushed to restore the walls to a prescribed thickness and corresponding strength. Much of this work is done by air-driven apparatus which can be brought into play without removing the cylinders from the locomotive.

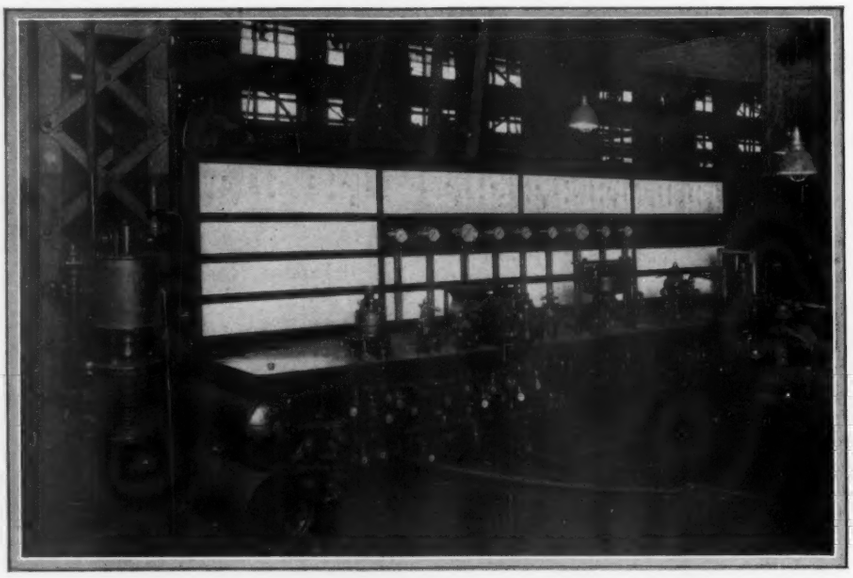
Locomotive safety valves, popularly known as pop valves, are given a preliminary test in the shop by compressed air—the facilities for this purpose being adjacent to the bench on which all air-brake valves, etc., are tested before they are issued for service. By testing pop valves in the manner mentioned it is possible to install such a valve on a locomotive which already has fire in its boiler but in which the water is not at the moment at the steaming point. This procedure obviates drawing the fire and saves both time and fuel. The space available for our story prevents further details about the many things that are done, and done well, in the main locomotive shop; but enough has been said to suggest the nature of the tasks that are handled there and to give a hint of the diversified ways in which compressed air expedites their performance.

Now let us make a hasty survey of the shops where freight and passenger cars are repaired and repainted. In this work are employed a total force of 490 men. Just what the activities amount to in the car-repair department can be realized by glancing at a month's record—that of November just gone. In that period the shops rehabilitated no fewer than 1,481 light and heavy cars. All passenger, diner, express, and milk cars of the system are taken care of at Sayre; and in addition to these the plant overhauls a large number of heavy box cars. Our illustrations give an idea of some aspects of this important repair work; and they also indicate a few of the many ways in which compressed air proves serviceable. Spray painting has greatly shortened the time and lessened the cost of painting both freight and passenger cars. With a sprayer, one workman can cover a box car in fifteen minutes whereas formerly two painters and a period of at least an hour were required to do the same amount of work. Not only that, but less paint is used in the spraying process. All metal cars are cleaned for repainting by means of sand blasting, and this effectually removes old paint and scale and prepares the surface for recoating.

It should be apparent to most travelers that the upholstery of day coaches is subjected to

Left — Removing excess moisture and raising the nap of a cushion by compressed air after the plush has been cleaned and redyed. Right — This air-operated machine shears the rivets of coupler yokes so that the yokes can be straightened and made fit again for service.

very rough treatment—especially when many persons persist in putting their feet upon the cushions. The Lehigh Valley Railroad has developed at Sayre a system of cleaning, dyeing, and rehabilitating these cushions so that they are made to look like new and are fit for further service. Compressed air blows the dirt and dust out of the fabric and the hair; and compressed air finally extracts the surplus dye and moisture—after scrubbing—and at the same time raises the nap of the heavy woolen plush. This system of renovation saves the railroad much money annually.



Test bench where all air-brake apparatus is tried out with compressed air before being issued for service.

Another evidence of the economies effected at Sayre is the work of the waste-and-grease reclaiming plant. When cars reach the shops for overhauling or repair, the greasy waste is removed from all journal boxes, and what otherwise might be considered refuse is subjected to a special treatment by which the waste is cleansed and the grease recovered. In this way both the waste and the grease can be used again. It is surprising how much of these essential commodities can thus be saved in the course of a single year.

With an eye to the future and with a realization that it is necessary to provide a continual influx of new blood, the management at the Sayre shops has instituted an apprentice school where finished mechanics in embryo are instructed in the duties of the various crafts employed about the plant. These apprentices, who are taking a 4-year course, assist the skilled mechanics in the shops; and they are paid the while enough to make them self-supporting. In one shop, so we are told, 26 foremen and mechanics have organized for the purpose of taking a study course in coöperation with the Pennsylvania State College. This ambitious group aims in this way to qualify for promotions that would have been well-nigh beyond their reach in the past.

Probably nothing has contributed more to the apparent general contentment at the Sayre shops than the organization of the Employees' Association, in the formation of which Mr. J. P. Laux, shop superintendent, has taken an earnest and a conspicuous part. The railroad placed at the disposal of the association a large building, which has been turned into an assembly hall. The men, themselves, laid a hardwood dancing floor with lumber given them by the road, and they constructed a fully appointed stage with commodious dressing rooms for performers. From talent in the plant have been recruited the members of a 30-piece band and a 10-piece orchestra. Hand in hand with the Employees' Association there is a Ladies' Auxiliary of 600 members, and, womanlike, they have and are taking an active part in decorating and in furnishing the assembly hall. Under the same roof are pool and billiard tables; and a cafeteria is being established.

Quite apart from what the Sayre shops represent in the way of progressive railroad management and well-developed efforts to bring about operating betterments, they are heartening evidence of a very suggestive trend in industrial relations. Splendid coöperation is found at every turn, and this unity of purpose is carrying the "E" of excellence to its third power by combining the factors of expedition, efficiency, and economy.

Black Diamond express of the Lehigh Valley Railroad. This is one of the several flyers which travel east and west daily over the splendid roadbed maintained by the line.

TRANSPORTATION of freight by air is being encouraged in every way possible in Great Britain and Germany. In London, the Imperial Airways, Ltd., is opening 25 new depots for merchandise to be delivered to various parts of Europe; and similar arrangements are being made in continental cities for air-freight service by British 'planes.

A number of specially equipped cargo 'planes are already in operation; and there is being worked out a system of packing freight of this sort in standardized metal containers. Furthermore, automatic fire extinguishers for flying machines have been undergoing tests in France for some time, and experiments are also being made with synthetic gasoline.

The German and Baltic services have developed considerable air-freight business—having carried 32,989 pounds during May, June and July, 1924, as compared with 16,744 pounds during the summer of 1922. The 1924 figure represents only 64 per cent. of the carrying capacity of the 'planes. The principal commodities transported are: pharmaceutical products, moving-picture films, perishable foodstuffs, spare parts and accessories, fancy goods, models, samples, fresh flowers, and banking documents. The rates vary with the distance—from 1 gold mark per kilo (2.2 pounds) for the Koenigsberg-Danzig flight to 10 marks for that from Koenigsberg to Moscow.

CLEARING HOUSE FOR INVENTIONS

THE American Institute of the City of New York, now in its 97th year, has just announced its program for 1925, which covers a wide field of service in the interest of the public. Among other things, the Institute will hold an Exposition of Inventions sometime this spring at the Engineering Societies Building, New York. The object of the exhibition is to offer inventors and others engaged in the advancement of work of this sort an opportunity to show their achievements as well as to give the public a chance to see what is being done in this direction. The Institute, furthermore, has undertaken to provide an all-year-round service acting as a clearing house for information about inventions and matters relating thereto.

Revival of Gold Mining in North Carolina

With the Use of Up-to-Date Facilities the Industry Promises Well

By E. H. PAULL

HOW MANY people know that North Carolina at one time produced much of our supply of gold? And how many of us are aware that after a lapse of several decades that state again promises to become an important source of this precious metal?

Some gold mining, both placer and deep mining, has been carried on in North Carolina ever since gold was discovered there in 1799; but after the Civil War work in this direction became fitful, output decreased, and the state dropped to an inconspicuous place among the gold-producing centers of the Union. Today, however, with the recent incorporation of the Rich Cog Mining Company, activities in this field are again being resumed. As a matter of fact, their mine at Eldorado, N. C., has been working and producing gold for the past few months.

Just what influence the revival of gold mining in the East will have on the industry as a whole has yet to be determined, but the indications are that the State of North Carolina will once more contribute generously to the nation's gold supply as it did over a century ago. But do not let us get ahead of our story.

Generally speaking, the mere mention of gold or gold mining brings to mind the West. While the majority of us had not made our appearance on this earth at the time of the great gold rush to California in 1849, still we are familiar with the circumstances of the event. Histories, story books, and motion pictures vividly describe and portray that great western movement, the hardships of the pioneers, and the subsequent opening up of the West—the birth of the West of today.

It may therefore come as a surprise to many of us to learn that gold was being mined in the East as far back as 1804, in short, that the State of North Carolina was the first and the biggest producer of that precious metal in the United States at the beginning of the nineteenth century. And in this connection it is interesting to note that the self same region worked in the early days is again being made to give up its stored riches.

For the benefit of those that are not familiar with the history of gold mining in North Carolina, it might be worth while to briefly mention a few of the outstanding facts. In 1799, a 17-pound nugget was discovered on the Reed plantation in Carbarrus County. This was the earliest known large find of gold in the state. Later, a mine was started on this plantation; and in the year 1803 a 28-pound nugget was taken out. This was probably the biggest nugget ever found in the eastern part of the United States. A model of it is on exhibition in the Smithsonian Institution at Washington, D. C.

Mining activities then spread into Rutherford and Burke Counties. Production was so

Fig. 1—Installing two air receivers at the rear of the compressor plant.
Fig. 2—At the 250-foot level of the Rich Cog Mine.
Fig. 3—Air-operated hoist in the engine-room. This double-drum hoist is used to raise the rock to the surface and to carry men and supplies up and down the shaft.
Fig. 4—Compressor plant in course of erection. These Ingersoll-Rand machines have a combined capacity of 1,350 cubic feet of free air per minute at 100 pounds pressure and will supply all the air needed for surface and underground work.

Here are a few of the 50 stamps with which the stamp mill of the Rich Cog Mining Company is equipped. This mill has a daily capacity of 125 tons of ore.

great and transportation to the United States Mint at Philadelphia so difficult that the gold obtained from 1831 to 1857 was privately coined in North Carolina in one, two-and-a-half, and five dollar pieces. These gold pieces were of standard weight and bore the mark of the coiner, "C. Bechtler, Rutherford County, N. C." They are now very rare.

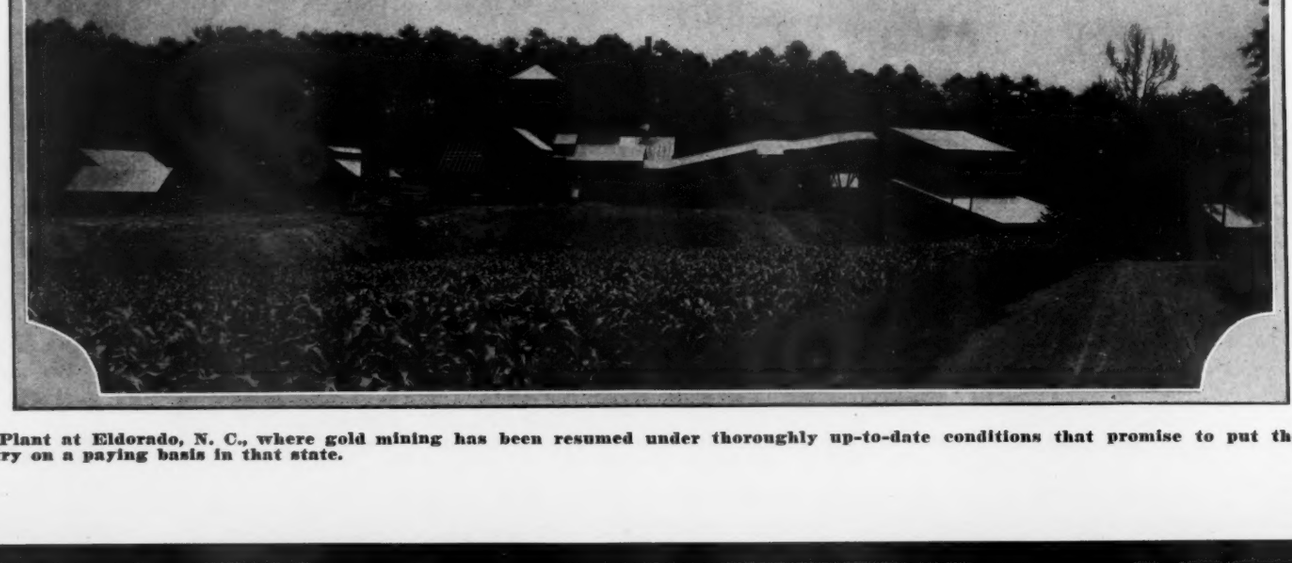
Mining operations during that period reached such proportions that the Government opened an assay office or branch mint at Charlotte, N. C., in 1837. This office was maintained until some eight or ten years ago, so that all bullion from that locality must now be sent to the Philadelphia mint. According to the latest statistics, the State of North Carolina has produced approximately $24,000,000 in gold. Some of the earlier mines were the Gold Hill, Silver Hill, and Conrad Hill. These were all worked before the Civil War. Later mines of importance were the Candor, which yielded gold valued at more than $1,000,000, and the Russell Mine. The Russell Mine was an open pit, 300 feet long 100 feet wide and 65 feet deep, and produced in excess of $750,000 worth of the precious metal. It might be mentioned here that the recently incorporated Rich Cog Mining Company is operating in the same county in which the Candor Mine was located.

During the Civil War, gold mining in North Carolina was abandoned, and, although operations were resumed soon after its close, the industry never regained its former proportions because of the excessive cost of mining and the wastage in recovering the free gold from the ore.

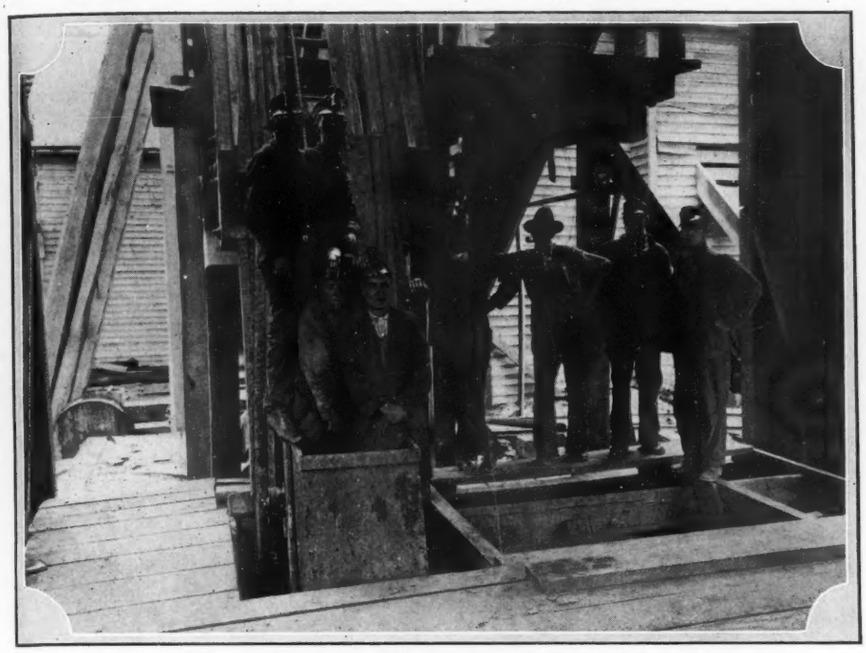
Hardly a day passes without most of us hearing or reading one or more of the many proverbs or adages that have been handed down from generation to generation. But, you will ask, "What have these sayings to do with the subject of gold mining?" The answer lies in the truthfulness of the adage, "History repeats itself." That is just what is happening in North Carolina. And full credit for the revival of gold mining there properly belongs to the late R. P. Richardson. It was due to his faith in the mineral resources of the state that the big undertaking was begun that finally resulted in the reopening by the Rich Cog Mining Company of the mine at Eldorado—the section that may rightly be called the "bull's eye" or center of the gold mining industry in the East.

This property, originally known as the Coggins Mine, was opened about 35 years ago. It was owned and operated by Colonel McCoy, a prominent and wealthy citizen well known throughout the state. Under his direction, a complete plant was erected and the mine developed to the 100-foot level. Operations were carried on in either direction from the shaft on both the 50- and the 100-foot levels; but the prospect was never worked to the fullest extent. After this venture the mine remained closed until 1911, when two coal miners from Pennsylvania took over the property. The workings were unwatered, and everything was progressing satisfactorily when the entire surface plant, including the mill and the mine buildings, and the underground workings to the 50-foot level were completely destroyed by fire.

In 1913, Mr. R. P. Richardson, a wealthy tobacco manufacturer of Reidsville, N. C., purchased the property, rebuilt part of the



Plant at Eldorado, N. C., where gold mining has been resumed under thoroughly up-to-date conditions that promise to put the industry on a paying basis in that state.



Miners ready to go down in the Rich Cog Mine.

surface plant, and unwatered and reopened the mine. Mr. Richardson had always believed that the deposits of the state could be worked profitably by using modern machinery and by adopting the latest extraction methods. To prove his contention, he bought the old Coggin property—now known as the Rich Cog Mine—and the Russel Mine, a mile to the eastward. The milling of all the ore was to be done at the Rich Cog, the raw material from the Russell Mine was to be transported by an aerial tramway to the mill located there. Mr. Richardson also acquired the property of the Riggon Hill Mine.

No work was done at either the Russell or the Riggon Hill mines, all efforts being centered on the Rich Cog project. The extensive program of development that had been adopted was continued until 1916, when operations ceased on account of the war. With the exception of keeping the workings free of water, the mine remained closed until 1922. Then operations were again resumed and continued up to the time of the death of Mr. Richardson, late the following year. In the early part of 1924 the heirs incorporated the Rich Cog Mining Company, with Mr. R. M. Hanes as president; Mr. P. W. Richardson, vice-president; Mr. R. P. Richardson, Jr., secretary; Mr. R. G. Stockton, treasurer; and Mr. Chas. E. Dickens, general manager. The eminent geologist, Dr. Joseph Hyde Pratt, has been associated with the company in an advisory capacity since its inception. The first step taken by the officials of the new company was to put the property on a production basis. They promptly started the construction of an engine house and a mill; and they bought new electrical and compressed air machinery both for underground and for surface work.

Under the direction of the late Mr. Richardson the 100-foot shaft previously mentioned had been sunk to a depth of 550 feet, and from this shaft had been driven over 3,000 feet of levels and crosscuts. In view of this fact, the present operators do not purpose doing any more developmental work at this time but will confine their efforts to the actual production of ore. It is estimated that between 100,000 and 110,000 tons are in sight, and of this total about 70,000 tons are already blocked out. The ore now being brought to the surface is taken from the 100-foot level and from those below it.

The ore-bearing strata at the Rich Cog Mine are classified as chloritic schist. The ore bodies consist of parallel layers embedded in slate and impregnated with iron sulphides and free gold with some quartz and calcite. The ore body as developed is 210 feet long and has a dike at each end. The width of the vein increases with the depth, being 18 feet at the 150-foot level and 24 feet at the 250-foot level. No attempt has been made to drift through the dikes; but the gold-bearing strata outcrop at both the north and the south ends of the dikes, proving that the ore body now worked is not merely a single pocket on the property.

A very rigid program of assaying was followed in reopening the mine; and a very conservative estimate of the ore blocked out places the value between $6 and $7 per ton. The policy of the company was to sample and to assay the ore every five feet of advance. The ore at the 250-foot level is extremely high grade, averaging over $200 a ton. It was on this level that Mr. Dickens, general manager of the Rich Cog Mining Company, found a 7-pennyweight nugget and several smaller ones weighing from 2 to 3 pennyweights. At the 400-foot level is a pay streak, 3 feet wide, that assays $88 a ton, and another, having a width of 18 inches, that runs over $300 to the ton.

The shaft has three compartments: two skipways and one ladderway. The skips used are of the self-dumping type and of one ton capacity. The surface plant, with the exception of the hoisting engine, is operated electrically; and the necessary power is obtained from the North Carolina Power Company over a 12-mile transmission line but recently completed. The 50-H. P. Florey double-drum hoist is air driven. All underground equipment, including "Jackhamer" and "Stopehamer" drills, and Cameron pumps are likewise operated by compressed air; and the drill steels are kept in condition by means of a "Leyner" No. 50 sharpener. Compressed air for all this equipment is supplied by two Imperial "XRB" compressors, one 13&8x12-inch unit and one 17&10½x14-inch machine having a total capacity of 1,350 cubic feet of free air per minute at 100 pounds pressure.

The ore brought to the surface passes over a grizzly—the fines going directly to a bin while the coarse material is first put through a Gates jaw crusher, set at two inches maxi-

Combined office and boarding house on the property.

mum, before being delivered to a bin. Next, the ore travels over two sets of 12-inch belt conveyers to a storage bin, of 175 tons capacity, in the stamp mill.

Being a free-milling ore, the amalgamating process of extraction is used. The mill consists of 50 stamps, 30 of 750 pounds and 20 of 850 pounds, with a total capacity of 125 tons in 24 hours. The ore is fed into the stamps under water pressure and stamped so that it will pass through 40 mesh. On leaving the stamps the ore goes over amalgamating plates or tables which are coated with quicksilver and which take up the free gold. There are 10 such tables, 50x120 inches in size, operating in batteries of five. About 87 per cent. extraction is obtained by this process.

The sulphide and rock particles which pass directly over the amalgamating plates are caught in a trough, whence they travel over a group of seven Wifley tables. The sulphides are concentrated and removed from the tables at one point while the rock particles are washed off as tailings at another. These concentrates, which amount to from 2 to 4 per cent. of the original ore, are treated by the cyanide process and yield 95 per cent. extraction. They are valued at from $50 to $200 per ton, depending on the grade of the ore. The tailings are not treated. The water supply for the mill is obtained from the Uwhare River, which flows within a few hundred feet of the mill.

The company is, indeed, fortunate in having an abundance of water available. It also owns approximately 1,000,000 feet of timber, consisting mostly of oak and pine, and runs its own saw mill. Furthermore, the company has absolute title to 650 acres of land and the mineral rights of 800 acres. There are 12 dwellings on the property, including a 11-room boarding house and office combined; and under normal working conditions the Rich Cog Mining Company's operating force at Eldorado will number 52 men. While the little town of Eldorado is remote from any city of size it is connected by very good roads with Denton, on the one side, and Troy on the other. Both Denton and Troy have good shipping facilities.

While the gold-mining industry of North Carolina merely "marked time" for decades, it has now struck a stride that promises well for the future.

A READY-MADE GAS HOLDER

NEAR SPRINGFIELD, N. Y., a great number of small and interconnected underground cavities, enclosed in a casing of impervious rock, form a natural gas holder having a capacity twenty times greater than that of any manufactured tank. This novel holder is now used for the storage of gas from different sources.

The gas is pumped into the reservoir during the summer to meet the increased demands of winter. As much as 350,000,000 cubic feet of gas has been kept in reserve there at one time. By metering the inflow and also the discharge of gas it has been determined that there is no leakage.

WORLD'S LARGEST BLOCK OF GRANITE

A WORLD record was recently broken in the granite quarry of the John Clark Company at Rockville, in the St. Cloud district of Minnesota. According to authorities, the block of granite that was hauled out of that quarry late in 1924 is the largest ever produced in the history of the industry, going as far back as the time of the ancients.

The stone, which was broken out by means of "Jackhamers," is 150 feet long, 75 feet thick, and 23 feet wide. It weighs 8,500,000 pounds, or is equivalent to the tonnage of a good-sized freighter. A smaller block, weighing 4,500,000 pounds, was removed about the same time.

Drilling a 7-foot channel with an X-70 hammer drill in cutting dimensioned granite.

While on this subject of quarrying, it might not be out of place to mention that the Campbell North Star Granite Company, operators of one of the largest granite quarries in the St. Cloud district, was among the first in that region to put the Ingersoll-Rand X-70 hammer type of drill in a comparatively new field of service. Two years ago, it was the general belief among quarrymen that dimensioned granite could be broached only by means of reciprocating piston drills. Now, however, the work is generally being done in the district in question by means of the heavier air-driven hammer drill.

With drills of this type, the speed of channeling depends mainly on three things: true alignment of the holes, spacing of the holes, and size of the bits. Taking these requirements in the order in whch they are named: to obtain true alignment of holes a long feed shell is of advantage, as it gives more guidance to the cylinder and enables it to approach closer to the rock floor. In addition, a guide for the steel should be used.

The spacing of the holes and the size of the bits depend on the hardness of the rock to be channeled. It is desirable to drill as few holes as possible per linear foot of quarry-bar length. This can be accomplished by employing large starter bits and by making the distance between centers as long as practicable consistent with ease of broaching. However, the larger the starter bit the slower the drilling, and the greater the distance between the center lines of the holes the slower the broaching. Consequently, a balance should be struck between increased drilling speed with a larger number of smaller holes per foot of quarry-bar length and slower drilling speed with a smaller number of larger holes per foot of quarry-bar length.

The results obtained by this method have been very satisfactory; and it has been reported from several granite-quarry sections that as much as 24 and even 27 square feet of channel has thus been drilled in a 9-hour day.

BIG CANAL TRAFFIC

THE most recent annual traffic figures for the three great ship canals of the world are: Manchester Canal, 4,273,544 tons; Panama Canal, 10,884,910 tons; Suez Canal, 17,574,657 tons—a total of 32,733,111 tons. The *Canadian Engineer* states that the combined traffic in the canal systems at Sault Ste. Marie, on the Great Lakes, amounted in 1922 to slightly more than 66,000,000 tons, or more than double the shipping in the aforementioned waterways.

We do not need to be reminded that the figures are not strictly comparable, as the conditions are so different; but they are at least interesting. The canals at Sault Ste. Marie are closed to navigation when ice forms, but the other canals are open all the year round.

THE average daily consumption of water per head in London for the year ending March, 1924, was 36.16 gallons—almost a gallon more than for the year preceding. The water consumption in New York for 19[illegible] was 130 gallons per capita, while in Chicago each person had at his disposal more than [illegible] gallons.

Compressed Air Provides Power For Open Foundation Work

Recent Experiences Emphasize Gains Made Possible by Using Compressed Air Instead of Steam

By FRANK S. HORTON*

COMPRESSED AIR is frequently depended upon by the contractor to furnish power for his equipment on jobs where it is necessary to use compressed air in large volumes, such, for instance, as in closed caisson and tunnel work. But compressed air is rarely utilized extensively for power purposes on what is known as straight building or open foundation work.

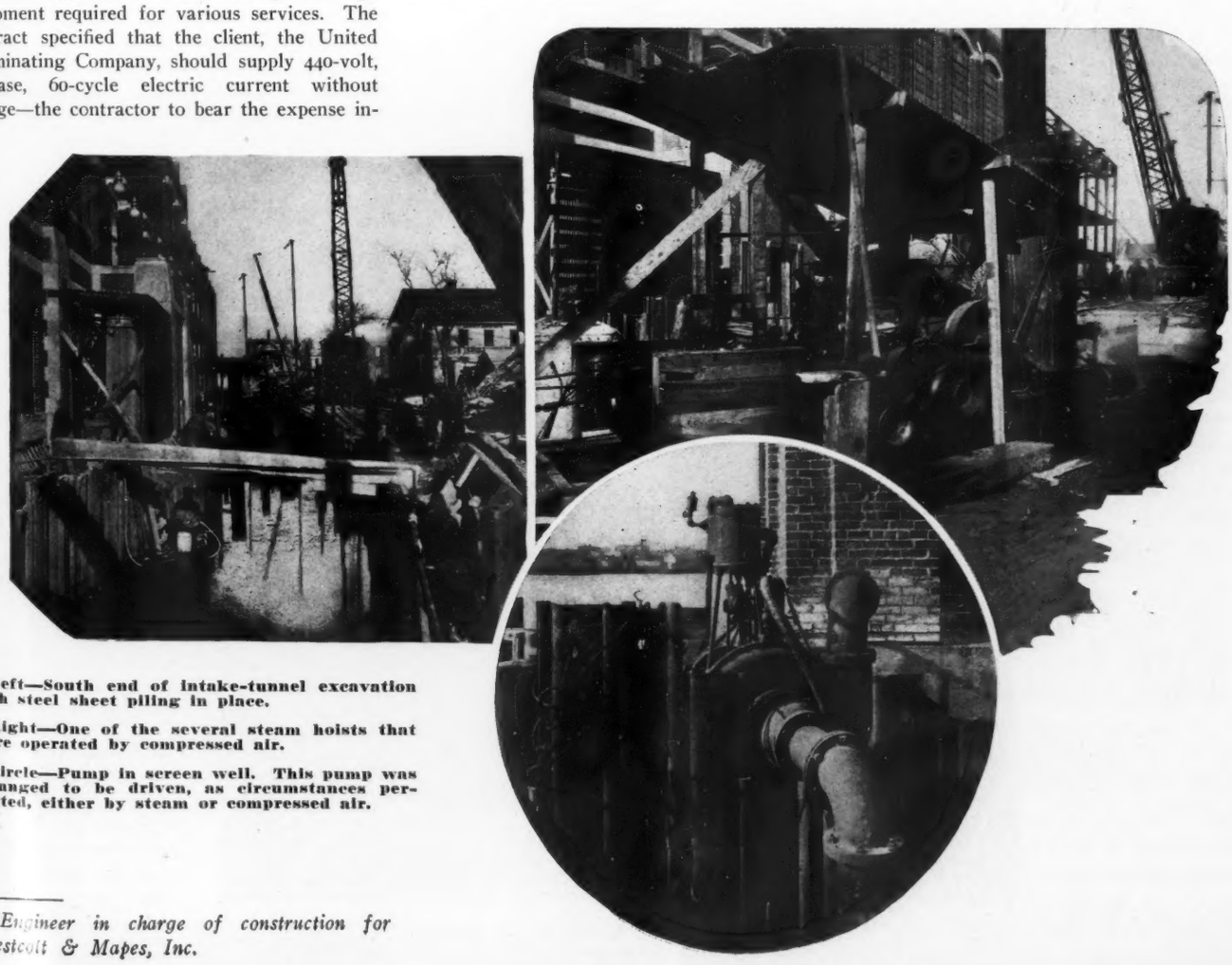
The purpose of this article is to describe a rather novel departure in this respect, and to tell how compressed air has recently been employed to advantage in place of the ordinary motive force, steam.

THE plant of the United Illuminating Company at Bridgeport, Conn., is undergoing enlargement—in fact, the addition now in process of erecting will double the capacity of this central electric station. The station is situated on what is locally known as Steel Point on the east side of the harbor, and much of the land occupied is made ground. The fact that a steel mill formerly stood on the site and that some of its foundations have had to be cleared away or broken through in carrying out operations in connection with the extension now in hand, adds point to what compressed air has done in lightening and in speeding up the needful operations.

The power-house extension is being built under the direction of Westcott & Mapes, Inc., of New Haven, Conn.; and the contractor immediately engaged in doing much of the work is C. W. Blakeslee & Sons Company. The latter, after a careful investigation, found the conditions very favorable for the economical use of compressed air for driving the large equipment required for various services. The contract specified that the client, the United Illuminating Company, should supply 440-volt, 3-phase, 60-cycle electric current without charge—the contractor to bear the expense incidental to running the needful wiring. Fresh water was also to be furnished the contractor by the client.

At the time the job was awarded, the contractor had planned to buy in the near future and for another purpose an air compressor having a rated capacity of 1,000 cubic feet of free air per minute at a pressure of 110 pounds. It became apparent that if this machine was obtained at once and set up temporarily for the period of the Bridgeport job it would result in a considerable saving in power cost. Therefore, an Ingersoll-Rand 18&11x14-inch, Type "XRE" compressor was secured. To drive the machine there was also bought a 177-H.P. General Electric synchronous motor having switching panels such as are furnished with this type of equipment.

It might be well to mention at this point that the compressor plant has furnished operating air for the different apparatus required in constructing a screen well and also intake and discharge



Left—South end of intake-tunnel excavation with steel sheet piling in place.

Right—One of the several steam hoists that were operated by compressed air.

Circle—Pump in screen well. This pump was arranged to be driven, as circumstances permitted, either by steam or compressed air.

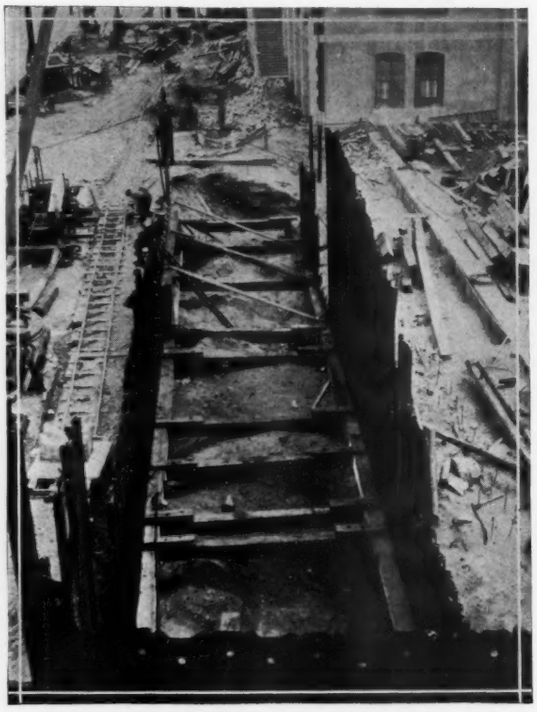
Engineer in charge of construction for Westcott & Mapes, Inc.

tunnels to convey water to and from condensers, which will be associated with three large steam-driven turbo-generator sets. The compressor plant was placed about midway between the screen well, at the south end of the job, and the north end of the intake tunnel; and it was properly housed to protect it from the weather. A 4x12-foot cylindrical air receiver was erected in the open just outside the compressor house; and a 5-inch header connected the receiver to a main which was run parallel with the tunnel. This main was reduced in both directions until the piping was 2 inches in diameter at the extreme ends of the line. Hoisting engines were hooked up to the main by means of 1½-inch connections. These are practical details which may interest some of the readers.

For handling materials and doing other work, the contractor brought to the job four 2-cylinder, 3-drum, 35-H.P. hoisting engines and four single-drum, 5-H.P. reversible engines to serve stiff-legged derricks having booms ranging from 50 to 60 feet in length. The 3-drum hoists have been used on the derrick tackles, while the single-drum reversible engines were installed to operate the bull wheels of the derricks. Virtually no changes had to be made in any of the equipment in order to use compressed air instead of steam, except to remove the exhaust piping from the cylinders. It was soon discovered that even a short length of pipe on the exhaust outlet would lead to the collecting of frost and the choking of the opening. This was due, of course, to the pronounced drop in temperature induced by the sudden expansion of the exhausted compressed air.

In place of the heavy cylinder oil ordinarily required when steam is employed for power purposes a light engine oil has answered admirably as a lubricant with the adoption of compressed air drive. In cool weather, however, it has been found advantageous to promote the proper flow of the lubricating oil by having recourse to some medium which would neutralize the low temperatures then existing in the cylinders. After some experimenting, wood alcohol proved effective for this service. Two sight-feed lubricating oil cups were connected to a common feed pipe leading to each cylinder: one of these cups contained light engine oil and the other carried wood alcohol. By regulating the flow from the two cups the desired consistency of the oil could be maintained so as to give satisfactory lubrication.

Two of the derricks were located along the intake tunnel. One of these was set up near the screen well, and the other was erected about midway of the length of the tunnel; and both of them have been utilized in placing the 14-inch, 40.8-pound, Lackawanna arch-web, interlocking, steel sheet piling which formed the retaining walls for the excavations. After the piling was placed in line it was driven down to the desired depth by a hammer operated by compressed air. All told, 6,295 square feet of this steel sheeting has been driven in the screen well, 11,060 square feet in the discharge tunnel, and 24,457 square feet in the intake tunnel. With the exception of a short period at the start of the work, all this piling has been unloaded from drays, swung into position, and driven by equipment relying upon compressed air as the motive force. The superiority of compressed air, especially for the operating of the hammer, was soon made apparent. This was mainly due to the absence of condensation.



North end of intake-tunnel cofferdam.

Steam at a pressure of 115 pounds was delivered to the hammer, and the practice was to drive the piling down to the point of refusal. By substituting air at 110 pounds pressure it was possible to develop 25 per cent. more driving power and to effect a correspondingly greater penetration after the steam had done its utmost. The greater penetration obtained by means of compressed air was very desirable because of the nature of the ground and the depth to which the enclosed area had to be excavated and unwatered. The hammer was provided with a somewhat novel guide which was arranged to grip the slotted edge of the pile contiguous to the one to be driven. This arrangement made it practicable for the derrick to drop the hammer into position and to cast off, after which the hammer would be set in motion and kept going until it had finished its work. Further the guide insured the vertical descent of the pile—in short, its correct alignment, something that is difficult to control when the hammer is suspended from a hoist or derrick during the whole of the driving operation.

The earth within the area surrounded by the steel sheet piling has been removed by excavating buckets handled by air-driven hoists and more than 7,000 cubic yards of material has thus been disposed of. One of our illustrations shows the intake cofferdam on the east side of the power plant, and another picture is of the diver employed in leveling the bottom of the excavation after the bucket dredges had completed their work as far as they could. That is to say, the buckets could not dig close to the piling; and, to bring the general level of the excavation to the prescribed depth, a trench was dug along the middle of the water bed and filled with flanking material washed away from the sides of the cofferdam by the diver using a hydraulic jet operating at a pressure of not less than 200 pounds to the square inch. A Cameron pump, designed for steam drive but worked by compressed air, delivered the water to the jet. It might be mentioned here that the diver obtained his air on several occasions from the compressor and not from the hand-operated diver's pump. This was rendered feasible by

Compressor house with outdoor air receiver.

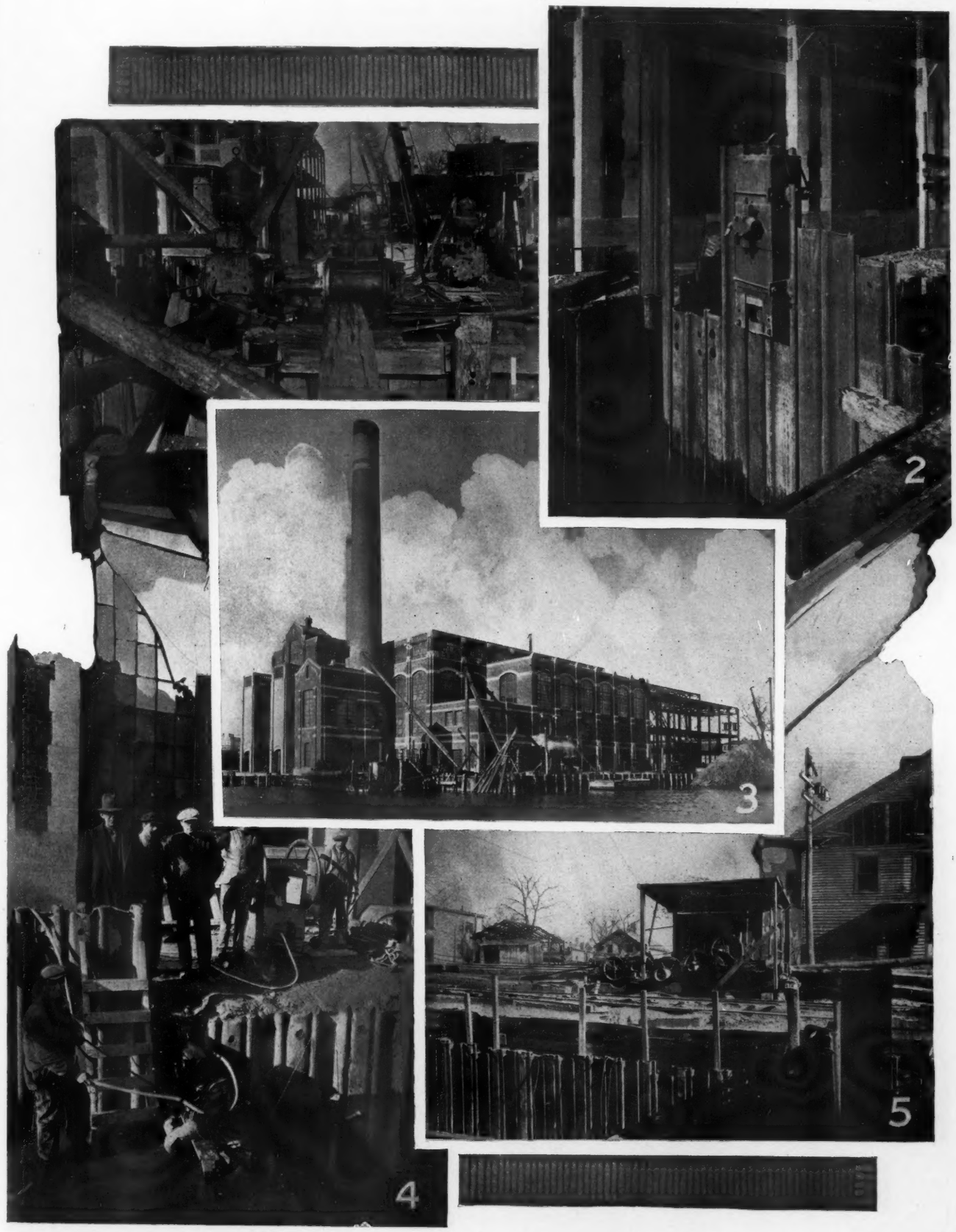


Fig. 1—This Cameron pump was air operated and has furnished water at high pressure for water jetting sand in the excavation for the intake tunnel.

Fig. 2—Pile driving was done by a power hammer actuated by either steam or compressed air. When using air it developed 25 per cent. more power than could be obtained with steam.

Fig. 3—The United Illuminating Company's fine plant at Bridgeport in process of expansion.

Fig. 4—Divers, with water jets, have leveled off the bottom of the excavation for the intake tunnel. This has been necessary where the dredge buckets could not work close to the steel sheet piling.

Fig. 5—Hoisting engine advantageously driven by compressed air instead of steam.

terposing a reducing valve in the line between the air receiver and the diver's hose.

To return to the derricks—which as we have already mentioned were arranged to run under compressed air instead of steam, one of these was erected on the harbor bulkhead and another near the concrete plant. These derricks handle the concrete materials. Sand and stone are delivered by barge to the derrick on the bulkhead and unloaded with a clamshell bucket. From there they are hauled by motor truck to the mixing plant. The derrick near the mixing plant places the sand and stone in overhead bins; and this derrick is also serviceable in unloading heavy materials delivered to the site.

In a construction job of the kind under consideration the control of water is one of the outstanding problems. In the case of the tunnels, it is necessary to deal well-nigh all the time with a 10-foot head of surface water. In addition to that the ends of the tunnels connect with outlets emptying into Bridgeport Harbor, and high tide increases the head to 16 feet. The head of water in the screen well, which is located beyond the sea wall forming the south boundary of the site, is 16 feet at low tide and 24 feet at maximum high tide. A 6-inch, motor-driven, centrifugal pump, installed on the tunnel, takes care of the water at high tide, while at low tide the water is handled by a 7x10-inch Cameron pump actuated by compressed air. In the screen well there are two 8-inch centrifugal pumps, one of which is driven by electricity and the other is operated by a 15-H.P. steam engine arranged to employ compressed air. Both pumps serve to lower the water early every morning. In the case of the engine-driven pump provision has been made to hook it up with the steam line so that this power medium can be resorted to whenever the compressed air is needed more urgently for other purposes.

The compressor already described has been able to furnish sufficient air to operate at one time a pile-driving hammer; two of the 25-H.P., 3-drum hoisting engines; two 5-H.P., single-drum, reversible engines; and a 7x10-inch Cameron pump working at about 50 per cent. capacity. When more equipment drew air from the line a drop in pressure naturally resulted, and to that extent performance was slowed up or modified. In addition to the apparatus mentioned there were certain small tools which were also driven by compressed air. To be specific, these were Ingersoll-Rand wood borers, used for boring heavy timbers, and "Jackhamers." The latter were brought into play in drilling old concrete foundations that had to be removed when clearing the site for the present undertaking.

To sum up, the job at Bridgeport has emphasized the fact that there are numerous ways in which a contractor can use compressed air to advantage where ordinarily steam is relied upon. Briefly, the benefits realizable are as follows:

A 50 per cent. saving in the labor cost of power generation, because no firemen are required on the job.

A 75 per cent. saving in the cost of lubrication. This is a conservative estimate.

A reduction in maintenance costs. When compressed air is used there is no expansion or contraction of pipes laid bare on the ground; and, therefore, no leaky joints are caused by this movement.

There is no drop in pressure due to condensation in cool weather.

No insulation is necessary to protect bare pipes from freezing.

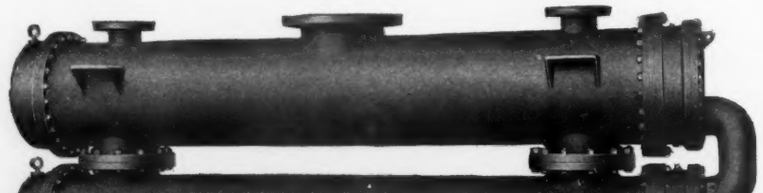
Liability risks are reduced as there is no danger of accidents due to burns or scalds.

A gain in cleanliness. Existing buildings are not smudged by smoke during construction activities.

MANYSIDED CONDENSER

A CONDENSER of particular interest to oil refinery men has been put on the market by The Griscom-Russel Company of New York City. This apparatus is built in sections, that is, two or more sections can be linked up, as desired. It operates either as a standard, reflux, or partial condenser, and can also be used as a condenser and heat exchanger at the same time.

For standard service, the vapor enters the upper shell and passes down through the successive sections over banks of tubes through which water, oil, or other liquid is circulating. When employed as a reflux or partial condenser, the vapor enters the bottom vapor connection and passes upward through the vapor inlet—the lighter fractions leaving by way of the upper outlet.



Sectional condenser made to serve several purposes in the refining of oil.

By still another arrangement it is possible to obtain a different "cut" or "fractionation" from each section. The lower vapor connection of each section can be offset from the side of the shell and the distillate drained from the basin thus formed in the vapor space.

The manufacturer points out that the condenser, besides being compact, is rugged; that it is easily assembled and transported; that it can be readily cleaned and inspected without disconnecting the water piping; and that the use of rolled-steel tube sheets prevents cracked plates or leaky tubes.

WEEVILS DESTROYED BY SAFER FUMIGANT

CARBON bisulphide has been used extensively, especially in box cars, for the destruction of weevils in wheat; but on account of its inflammable and explosive character it has been outlawed by the railroads. A new agent has been sought and, according to *Chemical and Metallurgical Engineering*, the search has been successful.

An admixture of two volumes of ethyl acetate and three of carbon tetrachloride has been found by the Bureau of Chemistry to be an ideal fumigant for the purpose. It is noninflammable, nonexplosive, leaves no objectionable odor or flavor, and does its work most effectually. In loaded cars, not less than 40 pounds of the gas is used per 1,000 cubic feet of air space. At present prices, the mixture costs 10 cents a pound. At that rate, and figuring the average box car to have a capacity of 2,750 cubic feet and to be loaded with 1,300 bushels of wheat, the cost of fumigating would be less than a cent a bushel.

The Hawaiian sugar crop for 1924 is estimated at about 701,000 tons—a record for the islands' plantations, or 176,800 tons more than the 1923 yield.

ARRANGEMENTS are being made for the laying of a gas main under the Hudson River from Newburgh to Beacon which, when completed, will be one of the longest of its kind in the country. The purpose of the main is to supplement the present supply of gas at Beacon. It is to be a 4-inch steel pipe, welded throughout, and will have a capacity of 100,000 cubic feet per day. For fully a mile the piping will be laid on the river bed in deep water and the approaches to the Newburgh and the Beacon plants will have a combined length of 1½ miles.

Modern Pneumatic Methods Halve Working Time in Lining An Old Sewer With Concrete

By A. M. HOFFMANN

THE JOB of lining an old sewer in the heart of the City of Brooklyn, N. Y., without diverting the sewage, is another achievement made possible by the pneumatic placing of concrete. The walls of this brick sewer were badly cracked in many places; and it was important that it be made proof against seepage—a condition that had rendered it dangerous and unfit for use.

Originally, the sewer, which has a length of 2,490 feet, was almost circular in cross section and about eight feet in diameter. This diameter was to be reduced considerably by removing some of the bottom bricks and by giving the entire inner surface a lining of concrete twelve inches thick. In short, when completed, the sewer was to be a little over six feet from top to bottom and to have a width at the center line of six feet. The concrete was placed in 15-foot sections; and wooden forms were used for this purpose.

Owing to restricted space, the concrete was dumped into a shallow box alongside the machine and then shoveled by hand into the hopper on top of the pneumatic placer.

The material was mixed at the top of a shaft, which was formerly a manhole, and shot through a pipe 25 feet long to small revolving scoop cars. Thence it was conveyed to a newly developed Ransome horizontal pneumatic concrete placer that is especially suited for work in confined spaces. This machine has an overall width of 2 feet 4 inches, a length of 8 feet 3 inches, and a height of 3 feet 2 inches. Its barrel consists of a cylinder 24 inches in diameter and 36 inches long. The discharge tee is placed at the forward end of the machine; and seldom, if ever, does concrete get into this tee prior to turning on the compressed air, which is used to force the mixture to the forms.

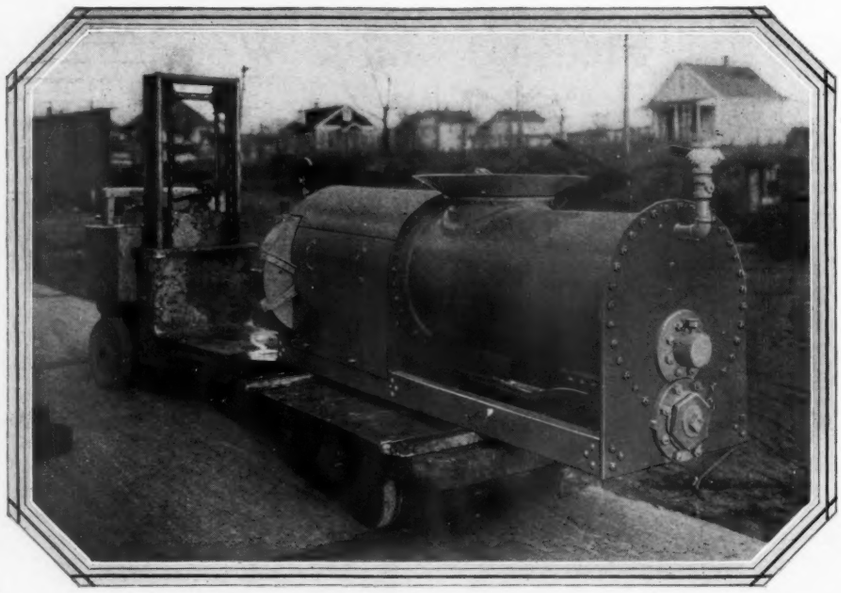
Inside the barrel or tank is a spiral, 12 inches in diameter, which is operated by a 7½-H.P. electric motor. As the feeding door is approximately in the center of the tank, this helicoid is used to keep the space directly beneath the door clear so that the full charge of concrete may be placed in the machine without jamming the opening. When the concrete is in the tank, the door, which is cone shaped, is closed by means of an air pump. The air is applied only at the tee; and, as far as can be determined from its action, the air fills the tank and the hose and, in escaping through the latter, produces a suction which draws the concrete from the tank and delivers it to the forms.

For a short shot of approximately 25 or 30 feet, as used in the case of the Brooklyn sewer job, the time required is about 10 seconds. Immediately after a shot, the spiral or helicoid is started and serves to carry forward what little concrete would otherwise remain in the tank. This material is picked up at the tee by the compressed air and blown

Left—Forward end of the Ransome horizontal concrete-placing machine showing connecting 6-inch hose by which the concrete was conveyed to the forms. Right—Rear end of the machine. Here we see the operator about to open the throttle of the compressed air line.

into the forms—the total time to handle a batch being about 15 seconds.

The method used in filling the forms was as follows: the discharge end of a 6-inch hose, which was substituted for piping, was inserted at the top center of the forms about 5 feet in from the end and the concrete shot against that which previously had been placed. This allowed the incoming concrete to fall by gavity on either side of the nozzle until the form was filled almost to the key. The keying-up process in work of this kind has been simplified to a great extent — concrete being placed pneumatically until only about one batch is needed to complete the filling of a form. In this way a sizable opening is left where the hose is inserted, but this does not show on the finished surface when the forms are removed. The next form to be concreted overlaps the newly placed concrete for about 6 inches, and the succeeding batch is shot into the hole just referred to—making at the arch an exceptionally good bond or key between the two sections.



Looking at the pneumatic concrete placer from the discharge end.

The accompanying photographs give a good idea of the size of the pneumatic placer in relation to the sewer. As there was not enough room to lift the cars and to dump their contents into the machine, the cars were brought from the shaft and emptied into a hopper alongside—two men shoveling the concrete from the hopper into the pneumatic placer.

As the total volume of concrete per form ranged between 15 and 18 cubic yards, anywhere from 60 to 72 shots were required to complete one 15-foot section—each batch consisting of 7 cubic feet of concrete. On account of the cramped quarters and the unusual working conditions, the actual time spent in concreting one form was about three hours. The regular capacity of the machine is 15 cubic yards per hour, using ¼-yard batches and delivering up to a distance of 45 feet.

In order to convey concrete under the same conditions with the gravity-type pneumatic mixer it is absolutely necessary to use a compressor rated at not less than 750 cubic feet of free air per minute. This quantity of air is required to fill the body of the tank—much of this contained pressure being needed to work its way through the entire batch, which is set directly over the discharge line; to force the free air out of the pipe line; and to overcome the inertia of the batch. In other words, there had to be air enough in the tank at the required pressure to last throughout the period of time required by the batch to drop by gravity into the tee.

The work in question was carried out by Booth & Flinn, Ltd., the well-known contractors of New York City, who encountered no difficulties in placing the concrete despite the handicaps under which the men had to labor. Only during heavy rainfalls and at periods of high tides was it necessary to discontinue operations. Even so, by reason of the air-operated facilities employed, the job was pushed to conclusion in half the time that would ordinarily be required and at a saving in labor amounting to 30 per cent. Furthermore, tests made under similar conditions have revealed that concrete placed as described by means of compressed air stands up better under compression than mechanically mixed and hand-placed concrete.

It is interesting to note that upon completing its work on the Brooklyn sewer, the horizontal pneumatic concrete placer was immediately called into service on the Holland Tunnel, as the New York-New Jersey Vehicular Tunnel is now known. The machine is engaged in lining with concrete the arch section of the first of the twin tubes that was holed through in November.

Pneumatic concrete placer seen from the control end and showing compressed air connection.

RESEARCH TO BARE SECRETS OF GULF OF MEXICO

THE naval scientific expedition, which is to commence operations in the Gulf of Mexico in July for the purpose of getting information and accumulating data concerning the ocean and its interrelation to the earth, cannot fail to be of immense service to the nation and to the world.

The origin, course, limitations, and climatic effects of the Gulf Stream are to be studied anew and more thoroughly than before. The ocean bed will be explored and its outcroppings examined for the purpose of determining the nature of the strata below — that is, whether they are present or potential sources of oil. The animal and the vegetal life with which the ocean teems, and the possibilities of making use of them, will also be investigated.

The Great North Road of Scotland, leading from Inverkeithing to Inverness, is to be rebuilt at an expenditure of about $4,000,000, including road building equipment. The road has a length of nearly 200 miles.

Driving a Two-Mile Tunnel To Tap a Mountain Stream

By K. M. BARRANCE*

WELLINGTON, the capital of New Zealand, is partly situated on the southern shore of Port Nicholson and partly washed by the waters of Cook Strait. Including adjoining boroughs, now within the metropolitan area, it has a population of 100,000. But a limited extent of the city, given over to the business section, is at sea level—the residential quarters have had to be built higher and higher up among the surrounding hills.

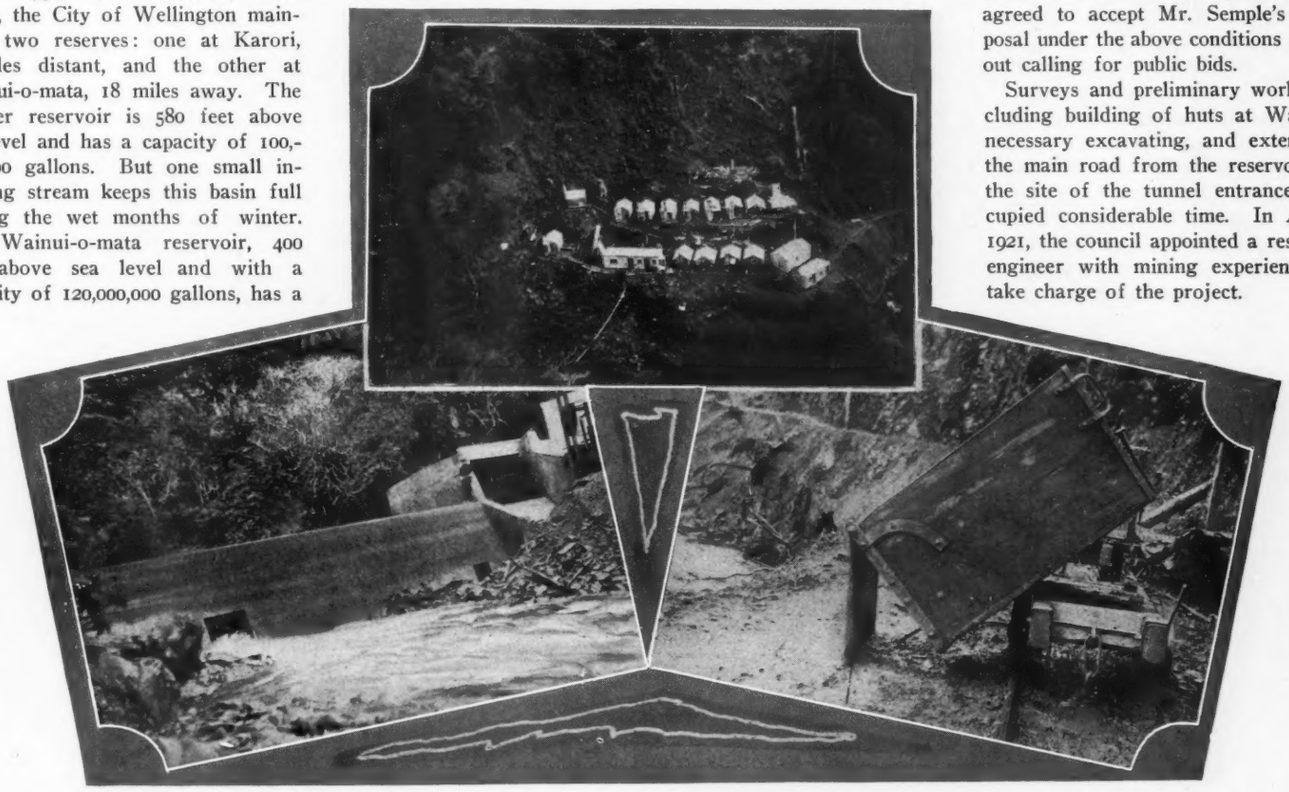
To supply the community with water, the City of Wellington maintains two reserves: one at Karori, 3 miles distant, and the other at Wainui-o-mata, 18 miles away. The former reservoir is 580 feet above sea level and has a capacity of 100,000,000 gallons. But one small inflowing stream keeps this basin full during the wet months of winter. The Wainui-o-mata reservoir, 400 feet above sea level and with a capacity of 120,000,000 gallons, has a catchment area of 10 square miles and is fed by two streams having a minimum summer flow of 3,000,000 gallons per day. This water gravitates to a service reservoir in the city, whence it can be pumped to smaller storage tanks to meet the requirements of residents at the higher levels.

Within recent years, in an attempt to provide 70 gallons of water per head per day, the supply in these reservoirs had been lowered below safe limits during the dry months from January to April. Something had to be done to augment the system; and it was therefore proposed by Mr. J. M. Morice, waterworks engineer, to draw on the Orongorongo River. This stream has its source in the same inland range of mountains as the Wainui River and, preserving a roughly parallel course, discharges about 3 miles further east into the Pacific Ocean. The ridge dividing the two rivers rises 3,000 feet above sea level, has an irregular surface, and is well covered with native bush to within 500 feet of its summit. East of the Orongorongo River is a higher but more barren mountain range.

The plan was to construct an intake dam, 800 feet above sea level, in the Orongorongo River and to pipe the water through a tunnel into the Wainui Valley. Thence it could follow the course of the existing main into the city and discharge into Karori reservoir or elsewhere. It was estimated that a 21-inch main could deliver 4,000,000 gallons per day, which additional supply would suffice until a large storage reservoir could be built. This scheme was endorsed by the late W. H. Morton, city engineer; and, when submitted by the council to a poll of ratepayers, received a vote of confidence and sanction to raise the necessary loan moneys.

About this time, Robert Semple, a prominent figure in labor movements in New Zealand, approached the mayor and councilors of Wellington and submitted a proposal to carry out the work of tunneling on a coöperative contract. The council was to provide power, machines, tools, timber, explosives, drill steels, lights, etc., as well as huts, while the coöperative party was to furnish all the labor required to continuously and expeditiously drive the tunnel from both ends and from 4 a. m. Monday to 4 p. m. Saturday; to do the drill sharpening; to cut the timber into sets; and to attend to the dumping of the spoils. Finally, it was guaranteed that the work was not to be interrupted by labor disputes. After consideration, the civic authorities—influenced perhaps by the uncertain state of the labor market at the time, April, 1920—agreed to accept Mr. Semple's proposal under the above conditions without calling for public bids.

Surveys and preliminary work, including building of huts at Wainui, necessary excavating, and extending the main road from the reservoir to the site of the tunnel entrance, occupied considerable time. In April, 1921, the council appointed a resident engineer with mining experience to take charge of the project.



Top—Terraces had to be cut on the mountainside before this construction camp could be established on the Orongorongo River. Left—Part of the dam across the Orongorongo River, showing intake chamber designed to prevent debris from reaching the water main during flood periods. Right—One of the ingenious tipping trucks used for handling spoils. These trucks were made right on the job by a blacksmith.

The larger of the two existing reservoirs situated at Wainui-o-mata is 50 feet above the smaller one, from which a 30-inch main leads to the city. By erecting a power house between the two reservoirs and by directing the city's daily draw-off of from 5,000,000 to 6,000,000 gallons from the higher reservoir through a water turbine before allowing it to flow into the lower one, it was possible to obtain cheap water power. The plant consisted of a small horizontal Francis turbine, of a belt-driven, 500-volt, 25 kilowatt, direct-current generator, and of one 12x10-inch Class "ER-1" air compressor. By way of a reserve, a steam plant was provided to furnish power during the dry season. A change over from one source of energy to the other could be effected quickly, and this was of advantage as the station not infrequently depended on water power during the day and on steam at

Engineer in Charge, Orongorongo Tunnel.

night when the city's draw-off was much less.

The tunnel mouth was situated 90 chains,* 5,940 feet, from the power plant; and compressed air was conveyed to a receiver there through 4-inch diameter cast-iron pipes provided with spigot-and-faucet ends calked with lead. The piping was laid on the surface of the ground, or supported upon rough timber trestles to keep it on grade when passing over depressions, small streams, etc., and was purposely of the standard type in service throughout the city for water distribution so that it could be used for that purpose upon the completion of the tunnel. In the tunnel itself, 3-inch galvanized-iron pipes with screw ends and couplings were utilized; and the air pressure at the drills was not allowed to fall below 80 pounds per square inch.

"Leyner" sharpeners in the blacksmith shops kept the drill runners amply supplied with properly shanked and bitted steels.

The temporary transmission line followed the 12-foot roadway and was held by span wires fastened to trees at convenient intervals to suit the bends. On half a dozen occasions, during stormy weather, the line was brought to earth by the breaking of a limb; but upon removal and the tightening up perhaps of an adjacent span wire it was restored to service without much delay. Besides being employed for lighting in and about the tunnel, electric power was used to operate a 2.5-B. H. P. motor in the blacksmith shop and one 12-B. H. P. motor direct coupled to a 20-inch, high-pressure Sirocco fan of the exhaust type.

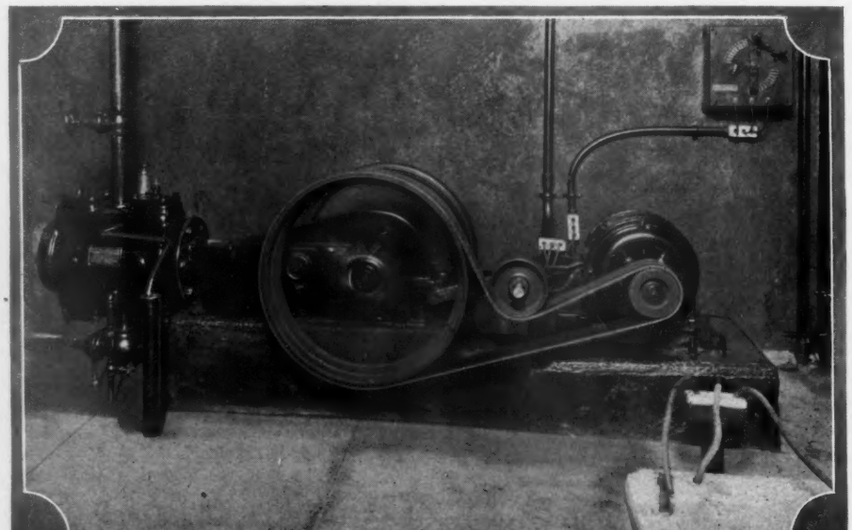
For ventilating, advantage was taken of the permanent 21-inch steel main which was eventually to convey the water through the tunnel. This main, which is made up of 24-foot lengths joined by couplings, was laid permanently on concrete stools standing over a drain. The main was not allowed to approach within 100 feet of the face: from that point back the air was carried to the main through a 21-inch diameter galvanized-iron pipe composed of short telescopic units and suspended from the roof. During blasting, 50 feet or more of the latter piping nearest the working face was moved out of the way; and, as an additional precaution, a 2x2x3-foot air box linked the permanent and the temporary pipe lines. By taking the lid off this box, the temporary piping did not get the full shock of the concussion and was, therefore, not buckled to any extent. Work could be resumed within 20 minutes after firing; and the volume of air did not fall below 3,000 cubic feet per minute, or double that required under New Zealand Government regulations.

To make the Orongorongo side easy of access, a pack trail 4 feet wide and a little more than 4 miles long was constructed between the two tunnel entrances. It zig-zagged up a spur, with grades less than 1 in 5, to a height of 1,500 feet and then rose gradually along the side of the ridge and over the dividing saddle, dropping in a similar manner into the Orongorongo Valley. This trail served only for transporting men and for packing foodstuffs and other lighter stores. Heavier supplies, in 2-ton loads, were hauled by 5-horse teams from the mouth of the river to the point of operations by way of the river bed. For the first ten miles of the run the river is wide and has a shingle bed, offering little difficulty to progress. But to make the last four miles passable it was necessary to build a roadway over the narrower, boulder-strewn bottom. During flood periods this road was for the most part under water and had subsequently to be repaired and cleared of boulders. However, it served to transport some 600 tons of material while the work was in progress.

At the tunnel entrance the Orongorongo River runs between fairly steep slopes that offered little flat ground for building purposes. A camp site was secured by cutting terraces into an adjacent sunny spur; and to get a foundation for a power house the river bank had to be dug into and a concrete wall built along the shore. An 8-foot truss bridge, with a 70-foot span and a carrying capacity of 4 tons, was placed across the river to give access to a small flat area which was occupied by a cement shed and stables and also afforded space for dumping the loads coming up the river road.

The dam site was situated 30 chains, 1,980 feet, above the tunnel entrance and was reached by digging a bench on one side of the river wide enough for a tramline and the main. The dam consists of a solid wall with an intake chamber on one side to prevent river debris entering the main during floods. The water flows upon the upper deck of this chamber through gratings with bars spaced one inch apart. The deck is pierced with numerous 2-inch holes through which the water passes to a double set of settling tanks, finally escaping over a second baffle wall through ⅜-inch mesh copper screens into the main. Scour pipes lead from the tanks back into the river; and, as the sand accumulates, these pipes can be opened by suitable valves.

The building of the dam took considerable time, as the work was interrupted by floods. Furthermore, to secure a firm rock footing, it was necessary to go down to some depth and to excavate much shattered rock. In the meantime, a temporary dam of logs and sand bags diverted sufficient water into a short length water race leading into the main, and this served to operate a turbine during the greater part of the time the contractors were



Electrically driven compressors of this make furnished the operating air for rock drills and other pneumatic equipment employed in the undertaking.

**We are assuming this to be the surveyor's chain of 66 feet.*

tunneling at this end. In the power house, a small horizontal Francis turbine operated a belt-driven 12x10-inch Class "ER-1" compressor, one 15-inch low-pressure Sirocco fan of the exhaust type, and one small dynamo used for lighting purposes.

Driving commenced at the Wainui end on October 12, 1921, but it was almost a year later before work was started at the Orongorongo end. The tunnel is 7x7 feet in cross section and has a total length of 10,523 feet; and a drain 18 inches wide and 12 inches deep was dug alongside one of its walls. The rock encountered consisted of hardened mudstone, locally called "graywacke." At times the drills struck bands of harder rock; but, on the whole, it was easy boring. By reason of minor faults throughout the rock formation, it was necessary to timber the tunnel for 20 per cent. of its length.

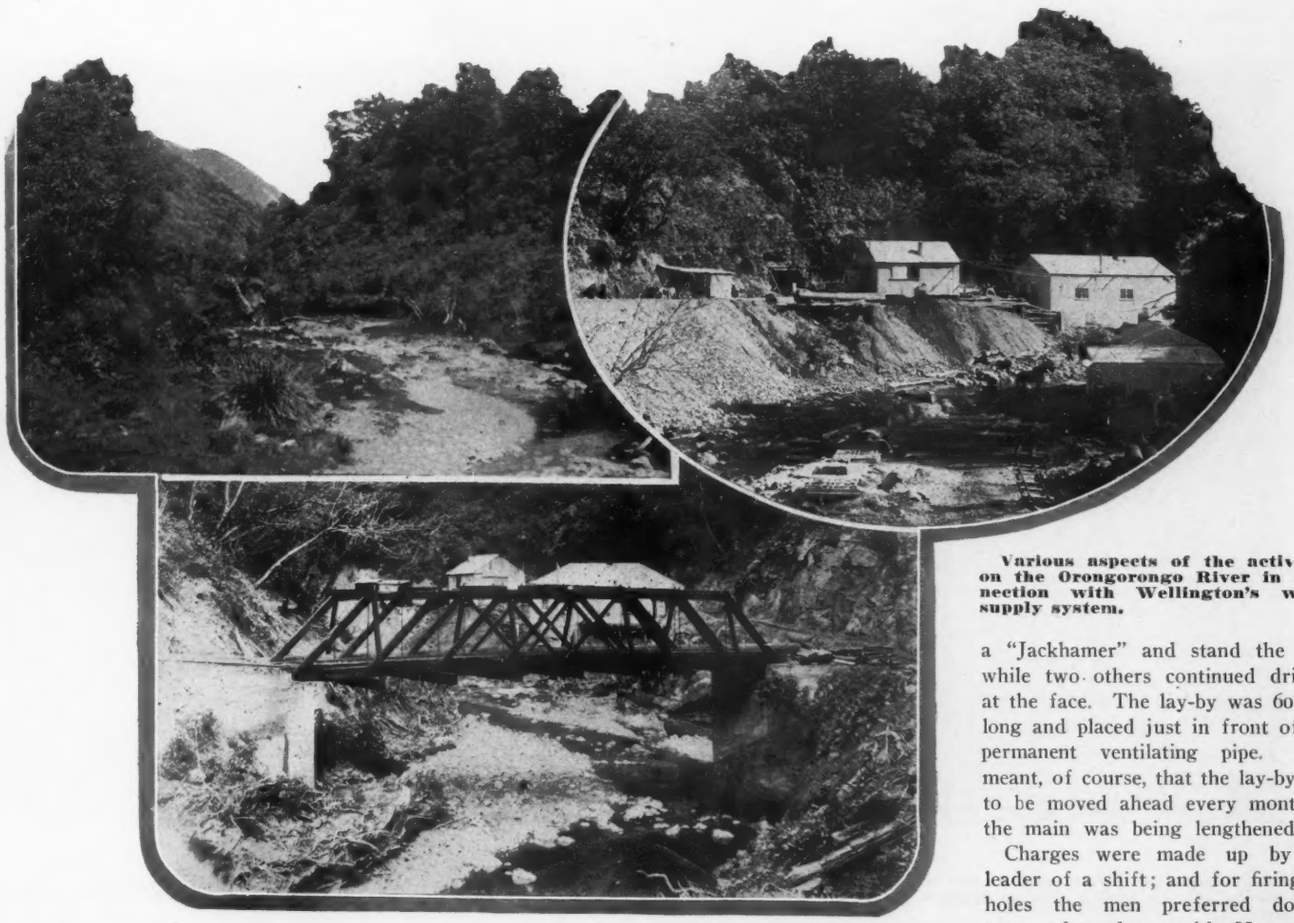
There was sufficient difference in level between the two portals to allow a rise of .63 per cent. and .2 per cent., respectively, and yet to keep the main under the hydraulic gradient between the dam and a discharge point on the Wainui side. Intersection took place 400 feet beyond the apex, as the team at the Orongorongo end drove faster than that on the Wainui side. The direction lines proved exact; and the grade pegs showed an error of less than three inches.

Two No. 248 "Leyner-Ingersoll" drills mounted on a horizontal bar were used for boring at each end, while a third one was kept ready in the respective blacksmith shop as a spare. The drill steels employed were 1¼ inches in diameter and had star bits in preference to chisel bits. The diamond-shaped cut was employed and was often obtained by drilling two converging holes from under the bar on the top set-up and one converging hole from over the bar on the lower set-up. As the ground hardened, additional holes, called "easers," were staggered around the first three. The total number of holes drilled in the face for each shot varied from 12 to 22 but was generally around 16.

In the best shooting ground, the average advance amounted to 7 feet for each round of holes; but the fastest progress was obtained when a crew finished the whole cycle of operations in one shift. This meant shallower holes, with an average advance of 5½ feet. But, even so, the rivalry among the men in each shift to complete a given task on time made for more progress in the course of a month than when longer rounds were drilled and when drilling or shoveling, as the case might be, ran into another shift.

Five men were employed on each shift. Two men rigged up the bar and commenced drilling with one machine. As soon as two others had finished shoveling and trucking to the lay-by they joined in the boring of the lower holes with the second machine. The men who shoveled on one shift usually drilled on the next. This was of advantage: it meant that the hardest work, that of shoveling, was more evenly distributed. Old boiler plates made excellent sollars for shoveling off. The fifth man was engaged in driving a horse, hauling a rake of trucks between the lay-by and the tiphead, and in dumping the spoils. When the latter had spare time he would also lay rails while the rest of the crew were boring out the lifters. Light, side-tipping trucks were used for mucking. These were made of wood, with steel doors and bottoms, and had a capacity of about 16 cubic feet each. Fifty of these trucks were in service; and they were built by the blacksmith on the job for less than half the cost of similar steel cars.

When the ground would permit, timbering was generally kept 30 or 40 feet back from the face. Two men would cut the hitches with a "Jackhamer" and stand the sets, while two others continued drilling at the face. The lay-by was 60 feet long and placed just in front of the permanent ventilating pipe. This meant, of course, that the lay-by had to be moved ahead every month as the main was being lengthened.



Various aspects of the activities on the Orongorongo River in connection with Wellington's water supply system.

Charges were made up by the leader of a shift; and for firing the holes the men preferred double-tape safety fuses with No. 7 detonators to the electric firing appartus provided. Gelignite was chiefly used; but a few packages of blasting gelatine or gelatine dynamite were always stored in the magazines to make sure of breaking out the cut holes if the ground did not shoot freely. An average of 4.6 pounds of explosive was required per cubic yard of rock; and the powder was kept 1,500 feet away from the working faces.

A week consisted of 44 working hours; and shifts were changed at the tunnel mouth. To avoid serious loss of time in going to and fro as the tunnel advanced a 4-wheel velocipede worked by hand was provided. On October 1, 1922, when rock drills were in use at both headings, the Wainui end of the tunnel had been advanced 2,640 feet and the Orongorongo

end had been driven by hand steel, a distance of 486 feet. An average daily progress of 18.4 feet was then maintained until the completion of the work on February 23, 1924. The highest monthly rate of progress at one end was 291 feet.

As the coöperative party had contracted to sharpen the drill steels, the blacksmith shop at the Wainui end of the job included a No. 5 "Leyner" sharpener with shanking device. Six additional men were employed to do this work as well as to cut timber into the necessary sets and to attend to the extension of the tramline at the tiphead. Thus 36 men were engaged on the contract. If men missed their shifts their places were filled by so-called wages-men employed by the corporation on surface work.

No serious accident occurred during the driving of the tunnel. Another fact worthy of mention is that with the exception of two men, whose health had previously been impaired by underground work, the coöperative party succeeded in keeping the same force on the job from start to finish. Apart from the fact that the project was being executed under very good terms, the members of the organization had bound themselves under a fidelity bond to see the contract carried through without interruption. A set of rules was drawn up governing their conduct; and every month 10 per cent. of their earnings was banked. Any member breaking these rules or retiring from the party before the completion of the undertaking forfeited his contributions.

Each man's share in this fund soon amounted to considerably more than his interest in the deposit demanded by the council; and the fund certainly had a restraining effect on those members who might otherwise have become discontented. Be all this as it may, it remains to be said that the shifts were always fully manned on Monday morning and that the guarantee given by Mr. Semple to the council was fulfilled to the letter.

Left—Temporary power plant built at the Wainui end of the undertaking. The installation included an 80-H.P. turbine, a dynamo, a compressor, and an 80-H.P. steam engine, which served as a spare. Right—Tunnel entrance, at the right, located about 2,000 feet below the dam site.

DRAWING STEEL WIRE

A MOST interesting paper describing the manufacture of steel wire was read not long ago by Mr. E. A. Atkins, before the Institution of Welding Engineers. The method of wire drawing, so we are told, is at least 500 years old and has been brought to its present state of development through innumerable refinements—the modern processes being extremely complicated in detail. Briefly, the basic material is first rolled down to rods, less than ¼ inch in diameter. These rods are pickled in hydrochloric acid, washed, and allowed to stand until they are "browned" or coated with a thin film of ferric hydrate. Then they are dipped in hot lime water and dried in an oven. With these preparations completed, the drawing begins.

There are two methods of drawing: a wet and a dry one, with different systems of lubrication, etc. As high as 1,000 feet of wire may be drawn per minute. Perhaps the most astonishing result obtained is the increase in tensile strength. A rod having a tensile strength of, say, 33 tons per square inch yields wire of No. 16½ gage with a tensile strength of 62 tons per square inch. By annealing this and drawing it down to No. 33 gage the tensile strength is raised to 85 tons per square inch. Similarly, a 0.75 carbon-steel rod, with a tensile strength of 57 tons per square inch, gives No. 33 gage wire with a tensile strength of 200 tons per square inch.

IT is believed by scientists that the world's greatest coal deposits lie in the Arctic regions. Evidence of this is found in the vast fields in Siberia and northern Alaska; and now Capt. D. B. MacMillan, back from a 15 months' exploration trip in the Far North, reports immense bituminous coal deposits in Ellesmere Land, less than 9 degrees from the North Pole. Coal beds 25 feet thick were discovered near Eureka Sound, which is 800 miles away from any means of transportation.

TELEPHONE WIRE STRESSES

OF the total telephone mileage in the Be system about 66 per cent. is undergroun cable, 22 per cent. is aerial cable, leaving only 1 per cent. of open wire. Judgment is require in stringing the latter to allow for tem perature changes, as the wires are nearly fi feet longer to the mile in the heat of sum mer than in winter. Therefore, if the wir are put up in other than extreme cold weathe they must be left more or less slack or the will give out when the cold attacks the Half an inch of sleet on a mile of telepho wire weighs about 3,000 pounds, and the tigh er and straighter the wire the greater will b the stress.

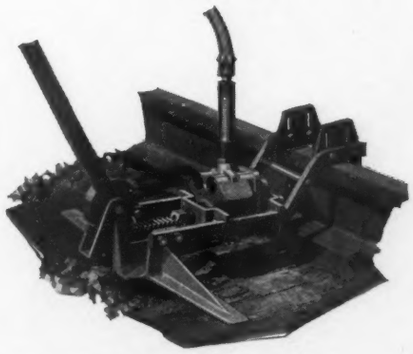
Maintenance of Way Methods and Practices on the Lehigh Valley Railroad

By G. L. MOORE*

SOME years ago I was a member of a committee composed of the chief engineers and the chief maintenance of way officers of each of the New York Central Lines. It was the duty of this committee to agree upon and to approve maintenance of way standards for all the New York Central Lines. We met every two months and discussed plans and methods, and while I do not recall that we adopted a single standard up to the time I left to go to the Lehigh Valley there certainly was a great deal of enlightening discussion at the meetings.

From one of these meetings I got an idea that developed into a method, which I was soon after enabled to carry out. I well remember the representatives of one of the important lines, which had to lay a great amount of new rail, bemoaning the fact that they had to face the enormous task of respacing the ties to fit the joints because, as it was then expressed, "there was no joint as strong as the rail."

I got to thinking of the joint question in general and wondering whether it was essential to have the ties come in exact position with reference to the joints. When I went with the Lehigh Valley Railroad, this matter of respacing ties to fit the joints became to me of increasing importance. I began to discuss this problem with the division engineers and supervisors. We began to look around and found one great railroad system where they said the rail ends must meet directly over the center of a tie. We found another great system where they said that the rail ends must meet directly over the center of the space between two ties. On the first system, when they laid new rail and the rail ends met between ties, they went to great expense to respace the ties so that the rail ends would meet directly over the center of a tie, while on the second system they went to great expense to respace their ties to the spacing which the first system went to maximum expense to get away from. Both of these systems had excellent track, and we came to the conclusion that we would adopt whichever of the two standards happened to best fit each individual joint and save the expense of shifting ties, which seemed unnecessary to us. Of the various new methods we developed from time to time, one of the first things we did was to stop the unnecessary work and expense of shifting ties to fit the joints and to devote the time and the money to other productive work.

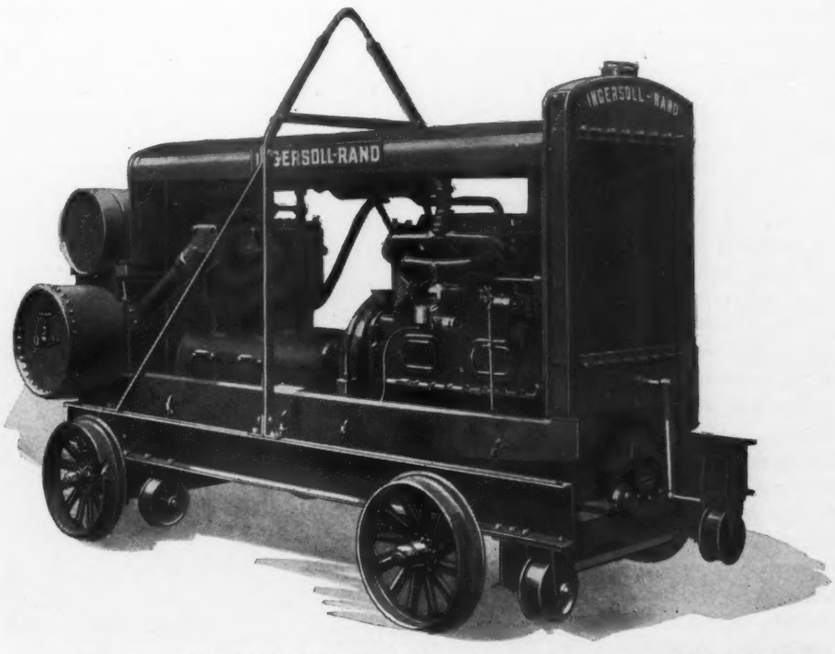


Air-driven drill for drilling holes for bonding wires.

During this time efficient anti-creepers or rail anchors became available. We at once began to purchase great quantities of them, as we had found that by applying them we could stop the creeping of the rails. This made possible the non-spacing of joint ties and also made practicable other methods which would perhaps have been impossible without the anti-creepers.

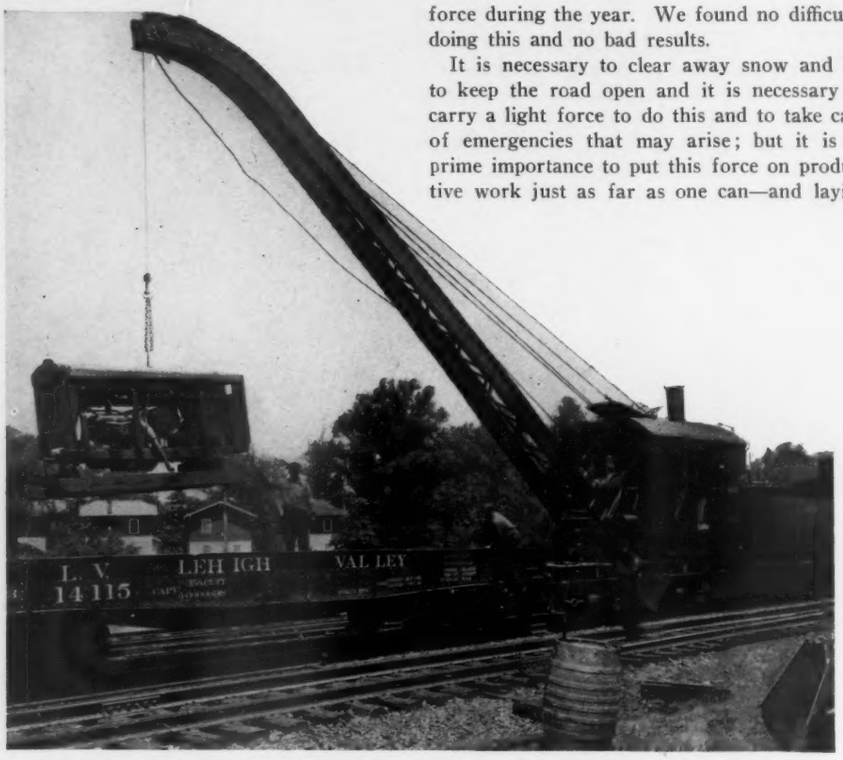
We next began to consider whether railroad track in general was at that time of strong enough construction to permit the realization of the greater economies to be obtained by a track construction which would be more stable—which would not require so much work to keep in shape. We came to the conclusion that there were not ties enough under the rails. We at once decided to increase the number of ties on our heavy-traffic tracks to 20 ties to a 33-foot rail. This gave us 45 per cent. of rail bearing on ties, and still left room for the proper hand tamping of the ties. It is possible that if practical power tampers had been available at that time we would have considered placing the ties even closer together. But we hardly believe there would be a sufficient gain to warrant a closer spacing, especially if the stone ballast is kept clean so that the angular, interlocking shapes of the broken stone retain the effect of transferring the load upon an increased area of the subgrade as compared with the area of the tie upon the ballast. To increase the number of ties from 17 or 18 to 20 per rail of course required the respacing of the ties. This work was done when the track was given a running surface, at which time tie renewals were made.

Where the stagger of the rail joints was accurate, so that a joint came practically opposite the center of the rail on the other side of the track, we did, in respacing the ties, place those at the joints so as to provide a suspended joint. Where the staggering of the joints had not been accomplished as accurately we did not do this as it would have placed the ties under one end of a rail closer together than under the other end of the rail, and we believed that it was of much greater importance to space the ties uniformly. The consequence of this was that we put up track with the ties spaced to fit the joints and also laid a greater amount of track where the ties were spaced uniformly without regard to the joints. We therefore had an opportunity to compare the results obtained by the two methods; and in both methods the ties, of course,



An automotive 9x8-inch, 12-tool tie tamper compressor, equipped with a lifting bail to facilitate putting the machine on or taking it off a working train.

Engineer, Maintenance of Way, Lehigh Valley Railroad.



Working train placing a 12-tool, skid-mounted, tie-tamper compressor right on the job.

were uniformly distributed under the rails. We cannot find any difference in the results obtained, but do find a great improvement over the kind of work formerly done in respacing ties under joints without much regard to uniform spacing under the rails, which resulted in too wide spaces between some ties and the bunching of ties at other points.

Today, in renewing ties, we always give the track a running surface, except in some special locations where local conditions will not permit, and renew the bad ties without again respacing, as they are now uniformly distributed. We have found in the use of the power tampers that it is possible to raise the track not more than about an inch and to thoroughly retamp it and overcome the effect of any center binding that may have occurred. Also, where there is sufficient ballast under the track it is most advisable to raise the track as little as possible as it will stay much better in perfect surface. Where track is given a running surface the heavy loads passing over it will cause settlement. When it is raised several inches this will affect the surface, but when raised only a very little this resettlement is not noticeable and the track remains in more perfect surface for a longer time.

Now that we had good anti-creepers and did not respace the ties to fit the joints we saw that there was no reason why we should not lay the new rail in the winter and thus, while directing the energies of the forces required to be carried through the winter, to perform productive work, at the same time relieving the summer forces of rail laying so that more work could be accomplished with the same force during the year. We found no difficulty doing this and no bad results.

It is necessary to clear away snow and ice to keep the road open and it is necessary to carry a light force to do this and to take care of emergencies that may arise; but it is of prime importance to put this force on productive work just as far as one can—and laying rail in the winter is one of the big items of productive work that it is possible to do in that season.

We adopted the method of laying long stretches of track in one day by taking the track and running trains around. A little later, over 10 years ago, we began to lay rail with locomotive cranes. This has been written about so much that it will suffice to say that it has proved very successful; and the officers of all departments interested would not consider going back to the method of laying rail under traffic.

In 1915 we designed the 136-pound rail section, and the first 136-pound rail was laid early in 1916, over 8 years ago. This rail is 7 inches high, its base is 6½ inches wide, and the section is otherwise of normal proportions. A part of the Lehigh Valley Railroad along the Lehigh River and over the Wilkes-Barre Mountain has steep grades and an alignment with excessive curvature with very sharp curves. The sharpest curve in the main line is a 13-degree curve near Mauch Chunk, while there are some 11-degree 30-foot curves, some 10-degree and many 8-degree curves. The balance of the main line through New Jersey, along the Susquehanna River in Pennsylvania, and through the Finger Lake region and the rest of New York State is of good alignment with light grades.

We believed, as we did when we started to thicken up the ties in the track, that to promote greater economy in maintenance the track must be made stronger. We were using stone ballast and were fast approaching the time when we would have sufficient ballast under the ties; we had improved the drainage by surface ditching, widening cuts, and placing sub-drainage through cuts; and had strengthened the track by building up the shoulders. In short, any further strengthening of the track had to be done by increasing the strength of the rail.

We had been stepping up in the size of the rail from 80 and 90 pounds to 100 pounds and some 110-pound rail, and had come to the conclusion that we had better go at once to the size of rail which, as nearly as we could figure would meet our requirements if not finally at least for a great many years. We had in mind economy in reducing rail wear by using a heavier section with harder higher-carbon steel. Also economies by having a big strong rail that would maintain the surface and line with the expenditure of less labor, that would distribute the heavy wheel loads over more ties, and that would relieve the individual t and thereby decrease tie renewals. Further, reduce track labor and to provide tie plates economical design and long life we placed th 136-pound rail on tie plates whose top w sloped to cant the rail in at an angle of 1 to 2

We have obtained all the results expecte and in greater degree generally than we h

In maintenance-of-way operations, the Lehigh Valley Railroad has found 12-tool, skid-mounted, tie-tamper outfits very useful.

Reversible, close-quarter drill used for running nuts on or off threaded bolts in track work.

hoped for. There is no such thing as spreading track on our sharpest curves. The average annual purchase of new rail in tons is less for the last 8 years, while we have been using 136-pound rail, than in former years. The tie plates are proportioned by reason of the sloping top so that they are thickest under the outside edge of the base of the rail where the greatest strength is needed; and from all appearances will yield a long period of service.

We began to use creosoted cross ties, switch ties, and bridge ties in 1910, and now about 70 per cent. of the ties in the track are creosoted. We have used a great amount of treated bridge timber. There is no question but that the creosoting of ties and timber has produced a very great saving.

As soon as practical power tampers became available we started to use them. We began with the 4-tamper machines; but after a little while we found economy in bunching two or three of these machines in batteries. Then the Ingersoll-Rand Company, at our request, developed the 12-tamper machine that we are using today. The air compressors of the tamping outfits are also used to operate air drills, pneumatic track wrenches, pneumatic wood-boring tools, cement guns, etc.

On the Delaware and the Susquehanna River bridges, with our present methods, we have replaced all the ties on one track of these bridges in one day by taking over the track, detouring trains over the other track the same as when laying rail, and using locomotive cranes to handle the ties. The Delaware River bridge floor is 1,103 feet in length and the Susquehanna River bridge is 1,808 feet long. This same method has, of course, been adopted on smaller bridges. Also, where necessary to renew the track stringers of some of the steel bridges, a track a day has been renewed by the same method—the larger part of the riveting being done on subsequent days.

In screening ballast with locomotive cranes, the foul ballast in the track is dug out by hand and thrown between the tracks. The locomotive crane picks up all the foul ballast between tracks to a depth several inches below the ties and dumps it on a screen in a car. Gates are provided so that the clean ballast can be deposited on the track or to either side of the track, while the dirt falls in the car and is unloaded later by the crane. Stone-ballast track cannot be economically or properly maintained if the ballast is allowed to become foul. It must be cleaned, and this is a very economical way to do it.

Ingersoll-Rand air-driven wood borer making holes for tie-plate wood screws. The screws are run home by a similar but larger pneumatic tool.

The Lehigh Valley main line is completely protected by automatic signals with interlocking plants, where required, and the heavy-traffic side lines are similarly protected as required. These signals have developed from the disk or banjo type to the position light signals which are now our standard.

We stopped purchasing crossing planks many years ago. The plankless crossings have been described so many times that I will not go into that subject here. Embankment shoulders have been built up with suitable material—ashes being generally used except along the rivers where light material would be washed away during high water. The maintaining of the shoulder at proper height and width we believe to be very important, and we have given that work a good deal of attention. Stable track cannot be maintained with weak shoulders.

We have a large equipment of locomotive cranes with which, among other things, we lay rail; clean ballast; renew ties on bridges; load and unload ties in slings, load and unload timber, piles, etc.; drive piles, using pile-driving leaders and steam hammers; clear slides; coal engines and load ashes; clear wrecks and pick up wrecked coal; stock coal and load stocked coal; erect bridges and other structures; handle freight; lay, raise, and line track in construction work; and handle all kinds of material and do many other things. We made up a list a few years ago which, I believe, showed 66 different items of work which had been performed by these machines.

Our policies and methods generally may be stated to have been developed around the following principles:

Avoid unnecessary work.

Avoid unproductive work.

Direct the energies of the forces to productive work at all times and seasons.

Perform work in the most thorough manner.

Find and use the most economical methods.

A few words now in regard to the general results obtained: Our average annual rail purchases in tons during the period 1916 to 1924 inclusive, during which time we have been using 136-pound rail only, are substantially less than the average number of tons of new rail purchased per year going back to 1905, when the heaviest rail weighed 90 pounds per yard and there was considerable 80-pound rail in use. During this same period the traffic on the road has very greatly increased.

The annual tie renewals have been decidedly decreased.

1920 tie renewals 116 per mile.
1921 tie renewals 133 per mile.
1922 tie renewals 77 per mile.
1923 tie renewals 91 per mile.

For the year 1924 they will be well below the hundred mark.

The average number of man-hours chargeable to expenses in the years 1915, 1916, and 1917, or the so-called test period, amounted to 10,496,749; in 1921, 8,782,642; in 1922, 8,776,115; and in 1923, 8,577,948, or 20 per cent. less than during the test period. For the present year the man-hours are so far running below last year.

The maintenance of way expenses for the calendar year 1923 per track mile, including all items, were $2,288.22, and for track items only, $1,426.55.

The average expense per ton of revenue freight carried 1,000 miles in 1923, including all items, was $1.3667, and for track items only, $0.8521. Track items only is made up of charges to the following accounts: roadway maintenance, ties, rails, other track material, ballast, track laying and surfacing, roadway machines, small tools and supplies, and removing snow, ice, and sand.

Each fall we hold a track inspection covering the main line in both directions. All the superintendents, division engineers, and track supervisors take this inspection trip. The various officers in the Transportation Department, who formerly were in the Maintenance of Way Department, are always invited, and two or three track foremen are taken along. The division engineers and the track supervisors do the marking, and each mile of track is marked. No prizes are given; but the results, by sections, supervisor's sub-divisions, and divisions, are compiled and published. It is surprising to note how uniform the maintenance is. Visitors from other roads on this trip always comment on this fact, and many times I have been asked how we decide who has the best track when it is all alike.

I cannot close without a word of appreciation for the men in the Maintenance of Way Department of the Lehigh Valley who have developed the methods described and made possible the economies resulting therefrom. A spirit of friendly rivalry has been developed that has a very great value, and there is a wonderful spirit of coöperation—every sub-department, every sub-division, and every division coöperating with its neighbors. These men are continually looking for new and better ways of doing things. I have great faith in them, and believe they will continue to bring forth new and better methods.

[*Paper read by the author before the Forty-Second annual convention of the Roadmasters' and Maintenance of Way Association of America, held in New York City, September 16 to 18, inclusive.*]

The establishment of a chair of gas engineering at Johns Hopkins University, Baltimore, has recently been announced by W. H. Taylor, vice president of the Georgia Railway & Power Company and president of the Southern Gas Association, which is to provide the financial support. Preliminary plans for the course have been worked out by a special committee under Edward L. Rieha, gas engineer of Baltimore.

REFRIGERATION HELPS TO CLARIFY CHAMPAGNE

ONE of the most vexatious problems in the production of champagne has been that of perfectly clarifying the precious liquid. This has hitherto been accomplished by keeping the bottles inverted for a long time and then by skilfully extracting the corks and removing the sediment upon them—much valuable wine being wasted in the operation.

A recent improvement, described in *Ice and Cold Storage*, employs refrigeration for this service. Brine at —4 to —13° F. is circulated in a tank, the cover of which is pierced with 48 holes large enough to admit the necks of as many bottles. The latter are carefully inserted, and in from 8 to 10 minutes the wine in the necks is frozen solid. Next, the bottles are successively withdrawn and reversed and the corks removed—the pressure of the contained gas forcing the small congealed portion together with the sediment out of the neck, leaving the remaining champagne clear and sparkling.

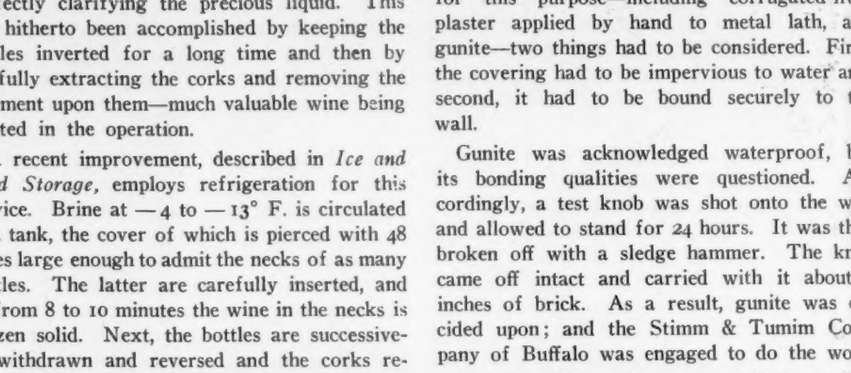
HALTING DISINTEGRATION WITH GUNITE

MUCH has been done within late years towards the protection of structures of one kind or another against the ravages of time. In this work, cement, applied with compressed air, has played a conspicuous part. An interesting job of this description was recently carried out in Buffalo, N. Y., in connection with a warehouse, the walls of which were in a bad state due to disintegration. The structure had been through a severe fire; and, in rebuilding, many of the old bricks were used. As the western wall, facing the Lake Erie waterfront, is exposed to the weather, the re-used bricks soon crumbled. Therefore, in order to preserve the wall, it became necessary to give it a protective coating of some kind.

In considering the several coatings suggested for this purpose—including corrugated-iron, plaster applied by hand to metal lath, and gunite—two things had to be considered. First, the covering had to be impervious to water and, second, it had to be bound securely to the wall.

Gunite was acknowledged waterproof, but its bonding qualities were questioned. Accordingly, a test knob was shot onto the wall and allowed to stand for 24 hours. It was then broken off with a sledge hammer. The knob came off intact and carried with it about 3 inches of brick. As a result, gunite was decided upon; and the Stimm & Tumim Company of Buffalo was engaged to do the work.

However, before the gunite could be applied, it was necessary to remove the old paint. This was done with the sand blast at the rate of about 600 square feet a day. The walls were then given a 1-inch coat of gunite; a 9x8-inch Ingersoll-Rand Type Twenty portable compressor supplying the needful air to shoot the material in place.



Compressed air made it possible to cover from 800 to 1,000 square feet of wall surface with gunite a day.

THE First National Bank of Boston has a new building which is up to date in every detail. Among other things, an air-washing system is installed for the purpose of purifying the ventilating air, and this washes and filters 200,000 cubic feet of air per minute. The air for this service is drawn into the building from a point 30 feet above the street level, and yet 5 pails of soot, dust, and other solids are entrapped and removed by the filters daily.

Unwatering Flooded Coal Mines With Air Lifts

By HERBERT AXFORD

THE AIR LIFT is a simple device and, as is the case with many other simple devices, some people try to give the impression that it is a very mysterious affair and that unless used in conjunction with some special apparatus, which they may designate, no satisfactory results can be obtained with it. The fundamental principle of the air lift is a column made up of a mixture of air and water opposed by another column consisting entirely of water. Consequently, if the weight of the column of air and water is less than that of the column of water a discharge of the aerated water will occur.

In order to get the most out of an air-lift system, certain conditions must be complied with—that is, the necessary pipes must be of the correct proportions, and the amount of air required and the pressure of the air must be determined. Also, the extent of submergence and the head or lift which the water has to overcome in being raised from the well must be somewhat correlated to get the best results.

A mistaken idea in many minds is that the air blows the water out from the bore hole. The water can, of course, be blown out by using a large quantity of air at a higher pressure than that required to lift the water; but the energy expended is enormous and out of all proportion to the extra amount of water raised. To overcome friction in the air line and to make up for other slight losses, the air pressure actually needed to lift the water should be just slightly in excess of the head of the water reaching from the water level in the well down to the point where the air pipe is introduced into the water pipe. This is termed the submergence.

Submergence is one of the things that must be taken into consideration in installing an air lift, and the extent of submergence varies with the height to which the water has to be raised. For instance, to lift water 400 feet from a deep well, at least 40 per cent. submergence is desirable, while 70 per cent. is advisable to raise it 20 or 30 feet. That is, if the water has to be lifted 400 feet, the well should be about 670 feet deep and the air pipe should be introduced into the water pipe 270 feet below the surface of the water, while in the case of the 30-foot lift the well should be about 100 feet deep.

On April 7, 1924, after heavy rains, the Lackawanna River reached flood height, cutting through its banks at Taylor, Pa., and pouring tons of water into the mine workings there. These mines are connected with the Hampton drainage scheme, which includes the Sloan, Hyde Park, Continental, Taylor, Holden, Bellevue, and National mines. Before the breach in the river bank could be closed and the water prevented from flowing into the mines, the Dunmore veins were flooded, as was also the main pumping station at the Hampton water shaft in the Clark vein. The water rose from 14 to 16 feet above the pump-room floor, completely submerging and putting out of commission the entire pumping plant. This was an extremely serious situation. With the exception of the water that could be handled by the auxiliary pumping equipments at Oxford and Holden, which were unaffected by the flood owing to their elevations and locations, it was impossible to take care of the usual inflow.

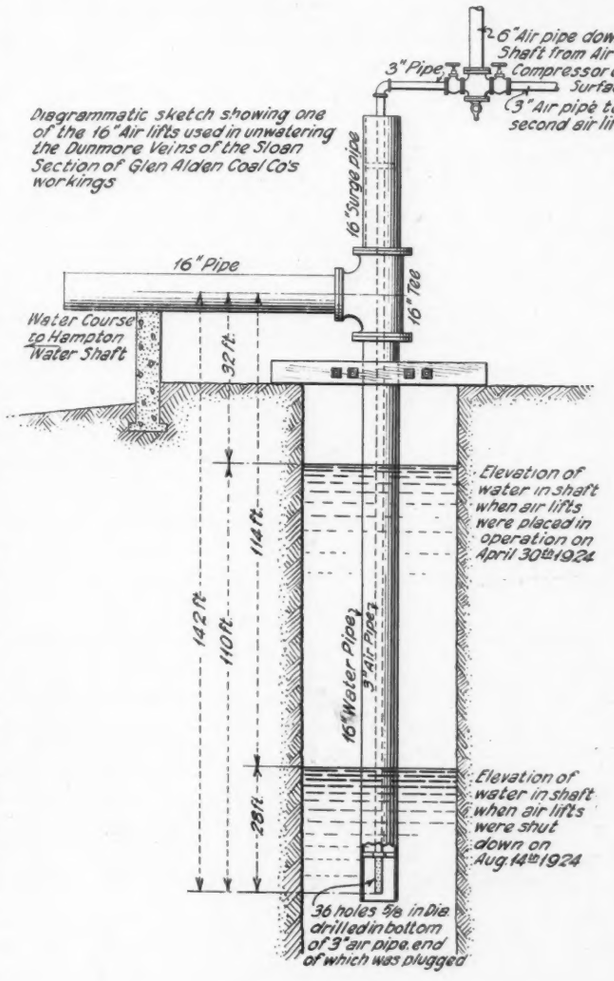

Diagrammatic sketch showing one of the 16" Air lifts used in unwatering the Dunmore Veins of the Sloan Section of Glen Alden Coal Co's workings
6" Air pipe down Shaft from Air Compressor on Surface
3" Pipe
3" Air pipe to second air lift
16" Surge pipe
16" Pipe
16" Tee
Water Course to Hampton Water Shaft
32 ft.
Elevation of water in shaft when air lifts were placed in operation on April 30th 1924
114 ft.
142 ft.
110 ft.
16" Water Pipe
3" Air Pipe
Elevation of water in shaft when air lifts were shut down on Aug. 14th 1924
28 ft.
36 holes 5/8 in Dia drilled in bottom of 3" air pipe end of which was plugged

Fig. 1

The pumping station in the Clark vein consists of five bronze centrifugal pumps, each having a capacity of 5,000 gallons per minute against a total head of 500 feet. These pumps are driven by 1,000-H.P. induction motors. The Nos. 1, 2, and 3 Dunmore veins, located beneath the Clark veins, are drained by small pumps placed in the various dips and discharging into the Clark vein watercourses. Ordinarily, one main pumping plant, running 24 hours a day, and one additional unit operating 14 hours daily handle the inflow of water. During wet seasons, however, auxiliary pumps are put in service. There is also a 3,500-gallon-per-minute water hoist which has not been used for several years. Orders had been issued to have it torn down; but, fortunately, the work of dismantling had not yet been begun when the mines were flooded. After some emergency repairs, this water hoist was again in service condition. At the Oxford and the Holden workings the auxiliary pumping equipments handle water, at a lower head, that would otherwise flow to the Hampton water-shaft basin.

The water handled is very acidulous; in other words, frequent repairs and renewals have to be made owing to its corrosive action. By reason of this fact, together with the importance of the station, it was necessary to provide considerable reserve pumping equipment; but this was not sufficient to cope with the emergency.

The mine water, after reaching the surface, is used for condensing purposes in the 10,000-kilowatt generating station of the Glen Alden Coal Company's power plant at Hampton. As might be expected, most of the pumping is done during the slack periods between peak loads, that is, from 4 p. m. to 7 a. m. on working days and for 24 hours on Sundays and on holidays. The pumping done week days between 7 a. m. and 4 p. m. depends entirely on the capacity of the power plant to carry the load and to meet the condensing-water requirements.

After the flow of the river was diverted from the mines and turned toward Wilkes-Barre, plans were formulated for installing emergency equipment. Several pumps were purchased and borrowed from other workings; but by the time these were received it was found that the water in the pump room of the main pumping station had receded considerably—having filtered down into some of the lower workings previously not inundated. On April 10, the water level in the pump room had dropped 10 feet and was still slowly falling. Some hopes were then entertained of recovering the main pumping station. A 1,000-H.P. motor was obtained from a reserve pumping unit at Storrs colliery and a 900-H.P. motor was bought from the General Electric Company. By the 12th of the month the water in the pump room had fallen so low that the Storrs colliery motor could be

substituted for the 1,000-H.P. motor on No. 5 pump. On the following day, with the water still about 14 inches above the pump-room floor, the newly installed unit was placed in operation. Next, on the 14th to be exact, the 900-H.P. motor was connected with pump No. 4 and promptly put in service. Thus the worst of the situation in the Hampton water shaft was met—the water at this time being well below the danger point. The motors on the remaining three pumps were then dried out; and before the end of the month all pumps were back in service. The Dunmore veins, however, were flooded—the water standing about 25 feet below the Clark vein landing in the Sloan shaft.

To unwater these veins it was proposed to use air lifts, inasmuch as the Glen Alden Coal Company had a large compressor available but not yet installed. It was suggested that two 16-inch pipe lines be placed as low as possible in the Sloan shaft; that a 6-inch air line be led from the surface down the shaft; and that this line branch off at the Clark vein to a 3-inch line leading to each 16-inch water line. The water from the latter line was to be discharged into the Clark vein watercourse, from which it could flow to the water shaft and thence be pumped surfaceward by the pumps already recovered. The compressor was to be installed on the surface as near to the Sloan shaft as practicable. This plan was finally agreed upon. The first air lift was placed in operation on April 30, and the second one on May 2.

The compressor, an Ingersoll-Rand Class "PRE-2" machine, had a piston displacement of 5,967 cubic feet of free air per minute and was direct connected to a General Electric 1,020-H.P., 4,000-volt, 3-phase, 60-cycle, synchronous motor. The compressor was put on a bed of heavy timbers in an old engine house near the Sloan shaft surface landing. When the frame and the cylinders were in place the whole timber foundation was solidly concreted. While the pouring of this concrete was in progress, the work of erecting the compressor was completed—thus allowing ample time for the concrete to set before starting up the machine.

A rough sketch of the arrangement of the air and the water pipes for the air lifts is shown in Fig. 1. As the coal company had sufficient standard steel, 16-inch-diameter casing pipe on hand, it was decided to make use of it for the water lines. Although the water, as previously mentioned, is normally quite acidulous, it was believed that this steel piping would last throughout the unwatering because of the enormous quantity of surface water with which the mine water was diluted. This proved to be the case, although the 3-inch wrought-iron air piping had to be renewed once.

A 16-inch, cast-iron flanged tee was placed at the upper end of the water piping—the horizontal branch leading the discharge air and water away from the shaft and into the regular watercourse. To the upper branch was secured a length of 16-inch piping with open ends to act as a surge pipe and also to allow the air to escape more readily. Owing to the amount of silt and rock, and to the quantities of trash that found their way into the bottom of the Sloan shaft it was not possible to lay the water pipes any lower. However, the air lifts were not expected to do more than to lower the water sufficiently so as to unwater the Dunmore No. 1 vein, which vein does not cut into the Sloan shaft, as other pumping equipment could then easily be installed to handle the water from other sources.

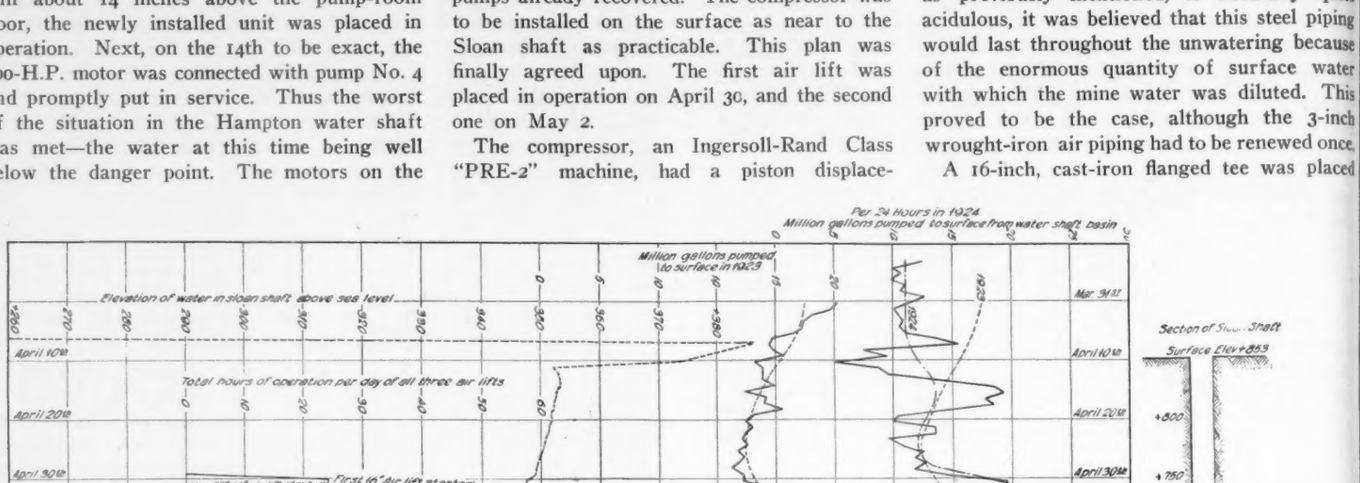

Per 24 Hours in 1924
Million gallons pumped to surface from water shaft basin
Million gallons pumped to surface in 1923
Elevation of water in sloan shaft above sea level
Total hours of operation per day of all three air lifts
May 2nd 16" air lift started
First 16" air lift started
May 16th 12" air lift started
July 16th 12" air lift stopped
Aug 14th all air lifts stopped
Elevation of water in Sloan Shaft
Hours air Lift in operation
Average for 1923
Average for 1924
Million gallons pumped for 24 hours in 1923
Million gallons pumped for 24 hours in 1924
Mar 31st
April 10th
April 20th
April 30th
May 10th
May 20th
May 30th
June 9th
June 19th
June 29th
July 9th
July 19th
July 29th
Aug. 8th
Aug 18th
Aug 28th
Sept. 7th
Section of Sloan Shaft
Surface Elev +853
Diamond Vein
Rock Vein
Big Vein
Clark Vein Elev +378
Dunmore #2 Vein Elev +208
Dunmore #3 Vein Elev +213

Fig. 2—Curves illustrating the performances of the regular pumping equipment in 1923 and of the air lifts which were installed in 1924.

After both 16-inch pipes were in use, it was found that the air supplied by the compressor was in excess of that required and that more water could be handled at the main pumping plant. Therefore, a third pipe, 12 inches in diameter, was put in the shaft. This well was ready for service on May 16, 1924.

Daily records were kept of the number of hours each air lift was in operation and of the elevation of the water in the Sloan shaft. The amount of water handled at the main pumping stations was also noted; and the accompanying curves have been plotted from this data. The upper curve shows the quantity of water, in millions of gallons, pumped daily from the Hampton water shaft, also the water handled by the auxiliary pumping equipment at the Oxford and the Holden workings from March 31 to September 17, 1924. The second curve shows the amount of water pumped from the same sources during the corresponding period of 1923. The water pumped to the surface from the 7th to the 13th of April, 1924, was taken care of by the Hampton water hoist and by the auxiliary equipment at the Oxford and the Holden workings.

Assuming that the natural inflow of water was the same in 1924 as in 1923, and this is said to be fairly correct, the difference between the two curves should give the amount of water handled by the air lifts. The records show that from April 30 to August 14, 1924, the time the air lifts were in operation, there was raised to the surface from the water-shaft basin 1,860,000,000 gallons of water. During the corresponding period of 1923, a total of 1,200,000,000 gallons was pumped—in other words, the difference of 660,000,000 gallons was discharged by the air lifts.

It will be noticed that the capacity of the 12-inch air lift is figured at just one-half that of the 16-inch lifts—thus giving a total service period for the three air lifts of 60 hours daily. On Sundays and holidays the air lifts worked continuously except for a short period when the compressor was shut down for examination or adjustment. The rest of the time the operation of the air lifts depended entirely on the capacity of the power plant to carry the load which, in turn, controlled the number of pumping units that could be run. At the rate of 660,000,000 gallons of water handled in 4,650 hours—the total number of air-lift hours—the average discharge from each 16-inch pipe was 2,360 gallons per minute.

According to the elevation of the water in the Sloan shaft during the period of the flood, the curve indicates that the air lifts lowered the water 82 feet, or from Elevation 348.5 to 266.5. The steep declines registered from July 29 to August 7, and on August 14, were due to the contour of the mine workings—the larger body of water being cut off from the Sloan shaft the air lifts handled only the water in the smaller basin draining to the Sloan shaft. At that time, however, the Dunmore No. 1 vein was uncovered, and the water in the other basins was being handled by centrifugal pumps installed at other collieries.

It is to be regretted that the actual performances of the air lifts—that is, cost, discharge at various submergences, amount of air used, and other data were not obtained; but the Glen Alden Coal Company was more interested in unwatering its mines. The company is satisfied that it secured this end at the least cost by the method adopted.

Shortly after the first air lift was installed, a weir was placed in the watercourse; and measurements then made showed that 6,200 gallons of water were discharged per minute from one 16-inch pipe working against a 40-foot lift, with 72 per cent. submergence. This weir was soon thereafter washed away and, owing to local difficulties, no attempt was made to erect something more substantial for the purpose of measuring the flow. The estimated discharge of 2,360 gallons per minute from one 16-inch pipe, having a submergence varying from 77½ per cent. at the start to 20 per cent. at the end, is considered a fairly good performance.

Thanks are due to the officials of the Glen Alden Coal Company for permission to gather the data and for the assistance given in the preparation of this article, which should prove of interest to the mining fraternity in general.

WORLD'S RAILWAY MILEAGE

THE Bureau of Railway Economics has issued a tabulation of the railway mileage of the world from which we get some interesting figures. The United States has more than one-third, and North and South America combined have over half of the total. The figures run like this: Total mileage, 741,175; North and South America, 371,741; Europe, 229,641; Asia, 77,961; Africa, 33,629; and Australia, 29,203.

The mileage of the principal countries is listed as follows: United States, 251,437; Canada, 52,155; Germany, 35,823; France, 33,281; Russia, 30,800; and Great Britain, 24,396. However, when we compare the mileage with the area of each country the story is quite different. In Canada, for instance, there are 71.5 square miles for each mile of road; in the United States there are more than 12 square miles; and Great Britain has a mile of railroad for every 3.63 square miles of territory.

"NIGGERHEADS"—FOOTPRINTS OF DINOSAURS

IN working the coal mines of Utah, the level of the roof above the coal seam is occasionally broken by the protuberance downward of hard, round pieces of rock which miners familiarly call "niggerheads." Hundreds of these have been inspected by Prof. William Peterson, of the Utah Agricultural College, and he agrees with the mine foremen and the superintendents that these peculiar formations are the tracks of monsters, long ago extinct, which tramped the primeval swamps.

The imprints seem to have been made when the peat accumulation, which is now coal, was covered with a foot or more of mud—the feet of the dinosaurs sinking through the ooze and down into the peat. Then, when the feet were withdrawn, the cavities filled with the mud which, in the course of the ages, was transformed into the bunches of stone now encountered in the Utah coal mines.

COMPRESSED AIR SAVED THE DAY FOR A DRILLER

DOWN in Calcacieu Parish, Louisiana, are located some of the domes from which we extract considerable quantities of sulphur by the combined action of very hot water and compressed air. To reach the rock sulphur it is often necessary to drill to a depth of 1,000 feet or so and to line the holes with piping—familiarly termed casing. This work occasionally bristles with more or less unexpected difficulties; and the following story, told by Mr. Zeiler of Joplin, Mo., is an example of what can happen in Louisiana and, possibly, elsewhere.

Some years back, Mr. Zeiler was a driller and had a contract to drill into a sulphur dome in Calcacieu Parish. For some weeks things went on without a hitch, but after the tools got down several hundred feet they could not be driven deeper. The rock encountered was not hard, because the spud was able to pulverize it, but the stuff caved in and filled the hole and acted like an elastic cushion. Neither could the casing, which followed close behind the string of tools, be driven through. At best, the casing could be forced down but a few inches and would instantly rebound or rise when the weight was taken off of it. Even dropping the spud the whole depth of the hole achieved nothing.

As Mr. Zeiler describes the situation: "I was face to face with a very disturbing state of affairs: if I couldn't get down to the dome it meant failure of a whole summer's work and a big loss, because I was under contract to make good. At night I went home worried, but told the men to go right ahead pounding away with the cable rig. I even consulted a practical driller of world-wide experience, but he could offer no solution—never having encountered a similar condition.

"In the morning I returned to the field and found, as I expected, matters unchanged. As a last resort and in desperation I decided to try compressed air. Frankly, I had so little faith in its efficacy that I hesitated to tell my men what I intended to do. However, I got my 'air gun' (air jet) ready, and let it down into the hole. When it came to the bottom I opened the valve wide. We didn't have long to wait for results.

"Almost instantly the air blast blew the pounded rock out of the way, and the casing sank so fast it almost got away from us: we had to do some hustling to get hold of that piping, but we were successful. From then on we had no trouble in blowing out the pulverized material as fast as it caved into the drill hole and, while passing through that formation, we were able to keep the situation in hand. Compressed air saved the day for us, and its use revealed something new in the field of drilling. Without it I am sure we should have been stumped."

THE new motor road through the Canadian Rockies, the Banff-Windermere highway, is the final link in the great 6,000-mile system known as the "Grand Circle Tour," said to be the most spectacular motor route in the world.

Compressed Air Magazine

—*Founded* 1896—

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EDITORIALS

The Season's Greetings

ONCE MORE, and with much pleasure, we wish our friends a Happy New Year. May everything that makes for prosperity and contentment be theirs in 1925.

Not by way of boastfulness but as evidence of widening service, we point to the fact that our circulation at the close of 1923 totaled 15,819, while our December issue of the year just ended was mailed to more than 23,000 readers. We are greatly heartened by this showing.

It is our earnest desire to make even a better record in the current year; and to this end we count upon the encouragement and the continued coöperation of our friends.

MINING MORE COPPER AND ZINC

THESE two metals fit into so many departments of life and into the requirements of so many industries that it would be difficult to trace the diversified uses to which they are put. In a general way, however, a brisk market for copper and zinc, such as has existed for months, is a fair index of business improvement throughout the length and breadth of the land. In the case of copper, however, no small part of the stimulated buying is directly traceable to the ever-widening popular interest in wireless telephony. Radio bugs, as they are commonly called, have measurably boosted the consumption of copper.

Reports from the West have recently revealed exceptional activities among the copper-producing companies; and one of these enterprises estimated that its monthly output for the year gone averaged about 16,000,000 pounds. At this moment the figures of zinc production in the country during 1924 are not available, but it is well known that the principal mines have been worked steadily and very energetically throughout the whole of the past twelvemonth. A great deal of zinc is used for galvanizing purposes; and galvanized commodities have innumerable forms and numberless fields of service.

To us, the growing demand for copper and for zinc is especially interesting because these metals can be effectively extracted from their rocky sources only through the agencies of compressed air and air-driven drills. This motive energy and these tools serve both to get the metals out of the ground and then to mill them and to otherwise treat them so that they will be fit for subsequent manufacture.

URGENT NEED OF GREATER HIGHWAY SAFETY

SECRETARY HOOVER has recently called to the attention of the public the appalling rate at which deaths and injuries on our highways is increasing, and he emphasizes the fact that 80 per cent. of these accidents are attributable to the careless or the reckless driving of automobiles. He recognizes the value of the automobile, and, therefore, makes it clear that greater safety can be obtained only by the adoption of corrective measures which will restrain the incompetent or heedless driver and properly punish those that violate protective regulations.

It is doubtful if the populace at large is fully aware of the enormity of the price paid annually in the way of loss of life and bodily hurt that result from automobile accidents. According to the National Bureau of Casualty and Surety Underwriters, there occurred in 1920 a total of 11,067 fatal automobile accidents, and in 1923 the toll amounted to 15,700 lives. The 1920 statistics show that 276,000 persons were more or less seriously injured that year, while the kindred record for 1923 reveals 392,000 injured by automobile accidents. It is authoritatively stated that 85 per cent. of all such accidents are preventable.

There are a number of contributing causes to this distressing showing. Undoubtedly a large percentage of these mishaps is due to flagrant heedlessness and to the disregard of traffic rules and of the welfare of other persons using the streets and highways. Again, a very considerable percentage of the accidents results from putting a piece of machinery in the hands of people almost wholly ignorant of mechanics; and this particular group expects the mechanism to act at times almost like a thinking being. When it doesn't, disaster is invited.

But there is a third and potentially a very fruitful source of peril, and this lies in the imperfect vision of the man at the wheel. Strange as it may seem, the motor-vehicle laws of but four states make any statutory reference to the eyesight of operators; and the provisions in the cases of these state laws are more or less vague—merely mentioning that the eyesight of applicants for driving licenses shall not be impaired or defective. In but five states it is the practice to test the eyesight of applicants; and it is easy to imagine how perfunctory or casual such tests would be during a rush period for licenses.

In May of the year gone, the police department of Detroit conducted a motorist's vision survey, and out of 1,654 motorists examined 26.4 per cent. were found to have vision below the normal standard. That is to say, 17 persons were blind in one eye, 133 had less than half vision in one eye, and 192 had less than two-thirds vision in one eye. These figures are significant; and if they apply with approximate accuracy to the millions of people driving motor vehicles the situation gives ample warrant for pause and very serious consideration.

OUR RAPIDLY REVIVING RAILROADS

IN OCTOBER of the year just ended, our trunk-line railroads moved 43,169,743,000 net ton-miles of freight, exceeding by 424,835,000 net ton-miles the previous high record established in August of 1920. These figures are heartening, in conjunction with other facts, because they show how the industrial life of the country is picking up and how the traffic arteries of the nation are successfully handling the distribution of a tremendously augmented volume of commodities. Not only that, but the railroads have prepared themselves to meet still greater demands, and by the exercise of diligence and foresight they have now ready for service a splendid reserve of locomotives and cars.

Class I railroads of the United States have authorized the expenditure for improvements in 1925 of substantially $1,000,000,000. This enormous sum is to be spent in many ways which have for their ultimate purpose the making of the railroads still better fitted to meet increasing traffic demands. The aim of the executives is to give in the fullest practicable measure that service which the public expects and knows to be possible under efficient management. In this issue are two articles which describe some of the improvements and some of the shop methods employed by a typically up-to-date line bent upon utilizing its resources for the common benefit of all concerned.

PASSING OF H. K. IVENS

IT is with deep regret we announce the death of Mr. H. K. Ivens, who represented the Ingersoll-Rand Company in New Orleans for more than seventeen years. Mr. Ivens was born at Tamaqua, Pa., July 29, 1860, and when nineteen years old he went to New Orleans and engaged in the machinery business with his father, under the firm name of Ivens & Son. For years the company specialized in the manufacture of cotton presses and low-lift centrifugal pumps—these pumps, invented by the father, being widely used for irrigating rice fields.

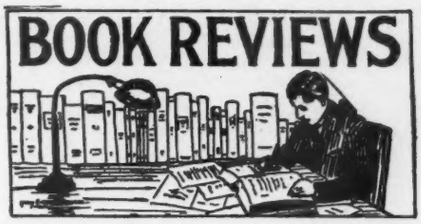
In 1907, Mr. Ivens went with the Ingersoll-Rand Company as agent for the Harris Air Pump Company, and remained identified with the company's interests until his recent demise. Mr. Edmund M. Ivens, for years associated with his father in the handling of Ingersoll-Rand and Cameron accounts in New Orleans, has succeeded to the management of this special agency.

LONG-DISTANCE CONTROL OF POWER STATIONS

WHERE water power is developed a long distance from the point where it is to do its work there is often considerable expense involved in maintaining a sufficient force for supervision and control at both ends, and much ingenuity has been shown in solving this problem. Perhaps one of the most noteworthy, up-to-date installations of this sort is a hydro-electric plant at Searsburg, Vt., according to *The American Miller*, which is automatically controlled from a mill at Mulberry, 100 miles away.

Up to the full capacity of the turbines and the water supply, the station may be depended upon to deliver not more than just a small margin above the energy wanted at any time. Not only is the starting, the stopping, and the continuous running of the plant provided for, but unforeseen conditions are taken care of. For example, if the bearings overheat, or some other hampering situation develops, the power is automatically cut off and the machinery will not start again until proper attention has been given to the source of trouble. Should the generator overheat, the waterwheel will be automatically thrown out of service, but will start again of its own accord as soon as the unit has cooled down to a degree of safety.

Mr. G. R. Phillips, division engineer of the Lehigh Valley Railroad, delivered at Athens, Pa., on the evening of December 8, an extremely interesting illustrated lecture before the members of the IRCO Club and their guests. The subject of Mr. Phillips' talk was the *Modern methods employed by the Lehigh Valley Railroad in its maintenance-of-way work*, and he brought out how big a part compressed air plays in performing the numerous jobs involved. Mr. John Draney, star engineer of the Delaware, Lackawanna & Western Railroad, followed Mr. Phillips with entertaining remarks dealing with the point of view of the man at the throttle of a fast express train who uses the roadbed prepared for traffic. Altogether, the evening was a great success.



A CHAPTER IN AMERICAN EDUCATION, by Ray Palmer Baker, Ph.D., Professor of English in Rensselaer Polytechnic Institute. A volume of 170 pages, published by Charles Scribner's Sons, New York. Price, $1.00.

EARLY in October of the year gone, Rensselaer Polytechnic Institute celebrated the one hundredth anniversary of its founding. The institute is the oldest school of engineering in any English-speaking country. At the start, Doctor Baker set out to prepare a historical sketch that would be appropriate for the celebration, but as he delved into the records of the institute he had it brought home to him how large and important a part Rensselaer has played in the technical educational life of the country.

Doctor Baker has done an excellent thing in the writing of this little book. In glorifying Rensselaer he has painted for us an inspiring picture not only of our educational expansion but how the work of the *alma mater* at Troy has reached out into so many of the departments of our national life which has made us great in the eyes of the world.

PRINCIPLES OF BUSINESS WRITING, by T. H. Bailey Whipple. A volume of 182 pages, published by the Westinghouse Technical Night School Press, East Pittsburgh, Pa. Price, $2.00.

THE author says: "Language not only is an essential and most effective business tool, but it differs from all other business tools in that it is a handle that fits all these other tools." The only trouble is that so many people in business unfortunately fail to effect the desired fit. This is in a measure due to a lack of training and to a wrong point of view towards the other fellow who is expected to read and to understand the communication sent him. Mr. Whipple recognizes that many of the graduates of technical schools have given but little attention to the study of language and have been called upon to write comparatively few letters—most of these being side issues and disposed of in a careless manner.

The book is not a compendium: it is more strictly a series of hints of how to avoid certain pitfalls; and the work should prove helpful to many by reason of the clearness of its presentation and the brief and direct way in which the different angles of the subject are handled.

THE BOOK OF THE LOCOMOTIVE, by G. Gibbard Jackson. This work, of 244 pages, is extensively illustrated—many of the pictures being colored. Published by Longmans, Green & Co., New York City. Price, $2.00.

JUST once so often we are reminded that the "iron horse," the steam locomotive, is doomed, and some of the public are misled accordingly. A vast deal of engineering skill over a hundred and more years has been directed to the development of the steam locomotive, and this effort to improve is still obtaining notable results.

Mr. Jackson has confined his attention entirely to the evolution of the British locomotive, and his story is an interesting and a very informative one. His book has in it much that should be worth while to any one in any country because its pages are full of valuable data.

CHEMISTRY IN INDUSTRY, Vol. I. Edited by H. E. Howe, Editor of Industrial and Engineering Chemistry. A book of 372 pages, with illustrations. Published by The Chemical Foundation, Inc., 85 Beaver Street, New York City. Price, $1.00.

MANIFESTLY, the book is one of a series which will ultimately embrace many more industries in which chemistry performs useful services. The present volume deals with chemistry's part in twenty departments of manufacturing—most of which make a popular appeal. The authors of the various chapters or papers are recognized authorities in their chosen paths of usefulness; and, happily, they have been able to tell their several stories in non-technical language which can be read with pleasure and understood easily. It is gradually dawning upon Americans how big a part chemistry plays in industrial self-sufficiency and national defense.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, Vol. I, 1924, edited by George C. Lloyd, Secretary. Published at the offices of the Institute, Victoria Street, London.

THE present volume contains sixteen papers, which were presented at the annual meeting held in London in May, 1924, with the discussions and correspondence thereon. Among the subjects touched upon are: *Continuous rolling-mills—their growth and development; The production of large crystals by annealing strained iron; X-ray studies on the crystal structure of steel; On the forging temperature of steels; The hardness of electro-deposited iron, nickel, cobalt, and copper*, etc., etc.

The Nordberg Manufacturing Company, Milwaukee, Wisc., is now licensed to build and to sell Armstrong Model 12 Shuveloders. These machines are primarily intended for underground shoveling work; and the company has issued for free distribution Bulletin DR-7. This pamphlet can be had upon application, and is intended to inform persons interested in the subject how they may reduce mucking costs.

A wooden floating bridge over the Hugli River at Calcutta, India, was built in 1874 by Bradford Leslie, an engineer, who guaranteed that it would last 25 years. It has already stood twice as long; and now Sir Bradford Leslie, at the ripe age of 93, has worked out estimates and plans for a bridge to replace the old one constructed by him half a century ago.

The origin of the bagpipe was being discussed, and representatives of different nations were successively disclaiming responsibility for this air instrument. Finally, an Irishman said: "Well, I'll tell you the truth about it. The Irish invented it and sold it to the Scotch as a joke, and the Scotch haven't seen the joke yet!"

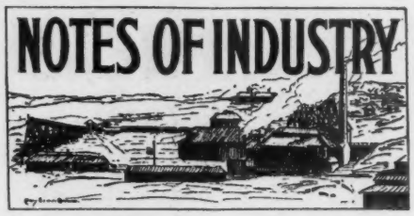
COMPRESSED AIR AIDS PAPER MAKING

A SERIOUS loss incident to the manufacture of newsprint is that due to "broke"—that is, damaged or waste paper—produced normally in the operating of a paper machine. Many efforts and much ingenuity have been directed towards lessening this loss; and among the most successful agencies to this end are the semi-automatic air-operated apparatus that have been developed by the Pope Appliance Corporation.

These pneumatic attachments permit one man to feed a sheet of paper from the wet end of a paper machine all the way through to the reel, and then to start a new roll on the reel. They further reduce the risks to which men working around moving machinery are generally subjected, inasmuch as the sheet is carried and conveyed by a current of air controlled by the operator—in short, the latter does not have to put his hand anywhere near the working parts. If a sheet in the making breaks it can be quickly started again with a marked reduction in broke. Obviously, the semi-automatic appliances make for speeds that would not be permissible if the paper were fed by hand from one to another part of the machine, and thus they not only reduce the amount of waste material but also increase output. It might be of interest to mention here that modern paper-making machines can turn out newsprint at the rate of 1,000 feet per minute.

To operate the Pope appliances, air at a pressure of from 60 to 80 pounds is required. The volume depends on the number and the size of the different attachments used, and the number and the size of the latter are determined by the type of paper machine. The automatic appliances begin their work by lifting the wet strip of paper and by blowing it upon and along the first felt. Then they carry the paper successively from the first to the second press, etc.—depending on the number of presses, and over the last felt roll into the driers. The sheet is next blown by jets of air into the calender stack. To do this the air is turned on the "doctor blade" of the last drier, and in this way the paper is forced through the iron guides into the stack. From the last calender roll the full sheet is lifted and directed by air deflectors and guides onto a reel for winding. This is accomplished by jets of air issuing from small orifices in a pipe secured under the last calender roll. When a new roll is to be started, a blast of air from a half-inch hose is played on the filled reel, and this serves to sever the sheet and to start it on a new winder bar. The completed roll is then removed for rewinding and cutting into rolls of suitable width for the printing presses.

Tin is one of the few useful metals not obtained in any considerable quantity within the continental limits of the United States. It is therefore interesting to learn that tin exists in Alaska and that several of the small prospects being worked there promise to become large producers. Already, more tin is mined in Alaska than elsewhere in the United States.



More than 5,000,000,000 containers of one sort or another are used in domestic shipping every year. In this connection, we are advised by the United States Department of Commerce that in 1922, because of improper packing, losses to railroads alone amounted to about $11,800,000. In the same year, the expense incurred by these carriers in repairing damaged containers reached a total of $5,000,000. These figures are, indeed, staggering, and it behooves us as a nation to take steps to stop or at least to lessen this unnecessary waste.

There are said to be 39 railway gages in use. But, omitting those with slight variations, this number is reducible to 8, as follows: 5 ft. 6 in.; 5 ft. 3 in.; 4 ft. 8½ in.; 3 ft. 6 in.; 3 ft. 3⅜ in.; 3 ft.; 2 ft. 6 in.; and 2 ft. The "standard" gage, 4 ft. 8½ in., applies to only 67 per cent. of the world's mileage, and nearly 52 per cent. of that is in the United States.

Meteorological conditions, according to *Tycos*, have an important bearing upon the refining of sugar cane. At Crockett, on San Francisco Bay, where the California-Hawaiian Sugar Refining Company maintains one of the largest cane-sugar refineries in the world, more than 60 instruments of various kinds are in continuous use to record the various elements which affect the refining processes. To a lesser extent, similar records are kept at beet-sugar refineries.

The large increase in Canadian trade with the United States, according to the Department of Commerce, is due not only to the proximity of the two countries but also to American capital in that market. At the beginning of 1924, foreign investments in the Dominion exceeded $4,500,000,000, of which the United States contributed more than 50 per cent.

The idle steam tonnage of the world has declined from over 11,000,000 gross tons on January 1, 1922, to about 6,000,000 tons on July 1, 1924. If this absorption continues, according to a forecast made by leaders in European shipping circles, all idle tonnage will again be employed in less than four years.

To replace worn-out cement sacks, the textile mills of the country are called upon to manufacture a strip of cloth 17,000 miles long and 30 inches wide. This material is sufficient for 30,000,000 sacks. Substantially 30,000 bales of cotton are required to fill this order; and it takes 1,600 looms, working full time for a whole year, to weave the cloth. A total of 200,000,000 sacks are in use in the United States at the present time for the sole purpose of distributing Portland cement.

The Ingersoll-Rand Company is building a direct reversible 400-H.P. marine oil engine to be installed in a tug for the Jersey City Stock Yards Company. The hull for this boat is being constructed by the Crowninshield Shipbuilding Company, Fall River, Mass. The tug is to be put in service about April 1, 1925, and will operate on the Hudson River between the Jersey City stock yards and various points in New York harbor.

There are approximately 234,000 miles of roads in India of which less than 1,000 miles, entirely within the municipal limits of large cities, are paved. About 69,000 miles are classed as metaled, while some 160,000 miles are unmetaled and for the most part unsuited to motor traffic. Bullock carts cause excessive wear; and the heavy rains of the monsoon annually do much damage to the nation's highways.

Just about 100 years ago work was commenced on the first Welland Canal, in Canada, which was completed in 1829. That waterway was superseded by a second one which, in its turn, gave way to the new Welland Canal, now in use. This, like those that preceded it, is soon to be made obsolete by the Welland Ship Canal, now more than half completed.

The United States—the first country to establish radio fog signals for the guidance of shipping—leads the world in this form of navigational aid. The Lighthouse Service now maintains twelve such stations. Canada has also made important progress in this direction.

Although silver ceased to be the standard of value in India in 1893, it is still chiefly used for the currency in circulation there. For the purpose of coinage, in the industries, and for hoarding by the natives, India imports annually from 80,000,000 to 100,000,000 fine ounces of silver—approximately 50 per cent of the world's production. The country is, therefore, the largest silver-absorbing nation in the world.

HELIUM

THE supply of helium for national service, both present and prospective, seems to be less restricted and uncertain than popularly supposed. Dr. R. B. Moore, formerly chief chemist of the United States Bureau of Mines, says that our present reserve of helium is enough to fill and to keep ready for service 200 *Shenandoahs*. Most of this helium has been obtained from natural gas in Texas.

Airships inflated with helium have but one-half the endurance of those filled with hydrogen on account of the condensation of water vapor; but methods of reducing this waste are being developed. At the naval air station at Lakehurst, N. J., there is a helium purification plant—the only one of its kind in the world—in which the helium is passed over activated charcoal at the temperature of liquid air. This process causes the absorption of all gases except helium and hydrogen—thus producing purified helium almost 100 per cent. efficient in buoyancy.